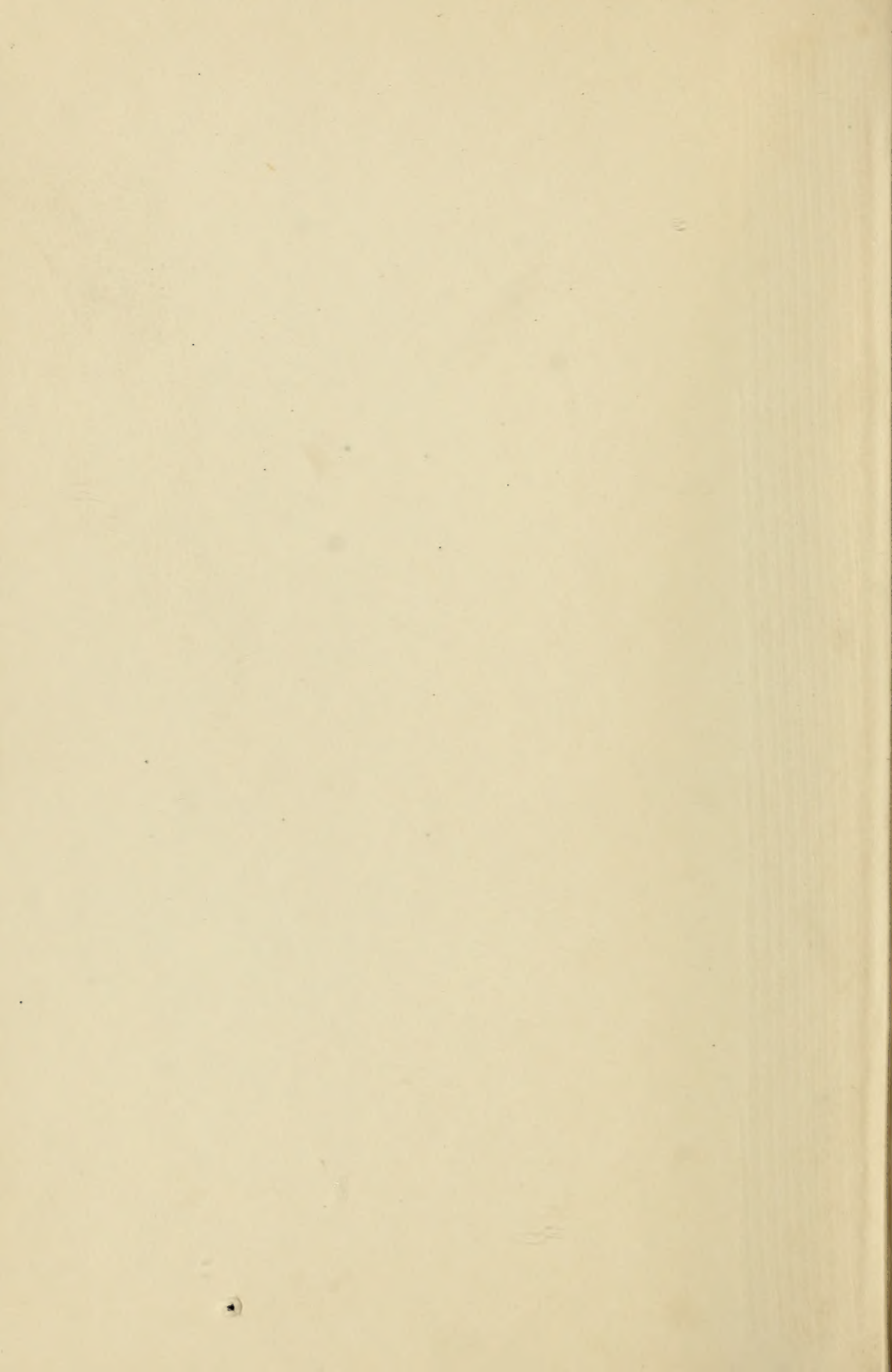
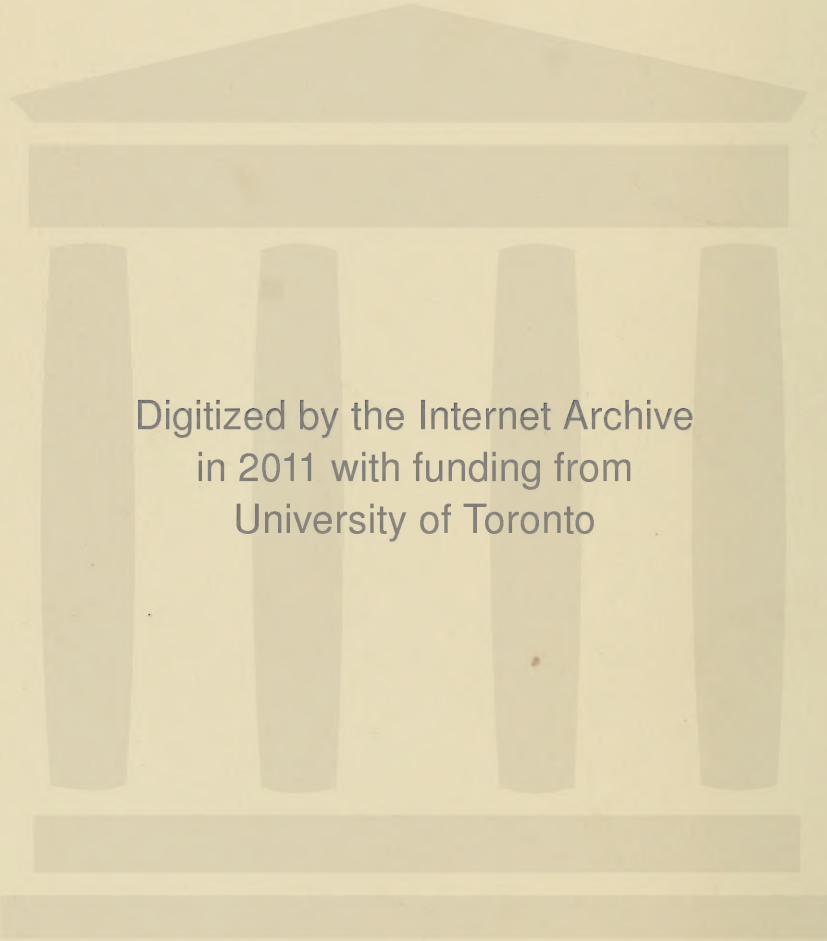
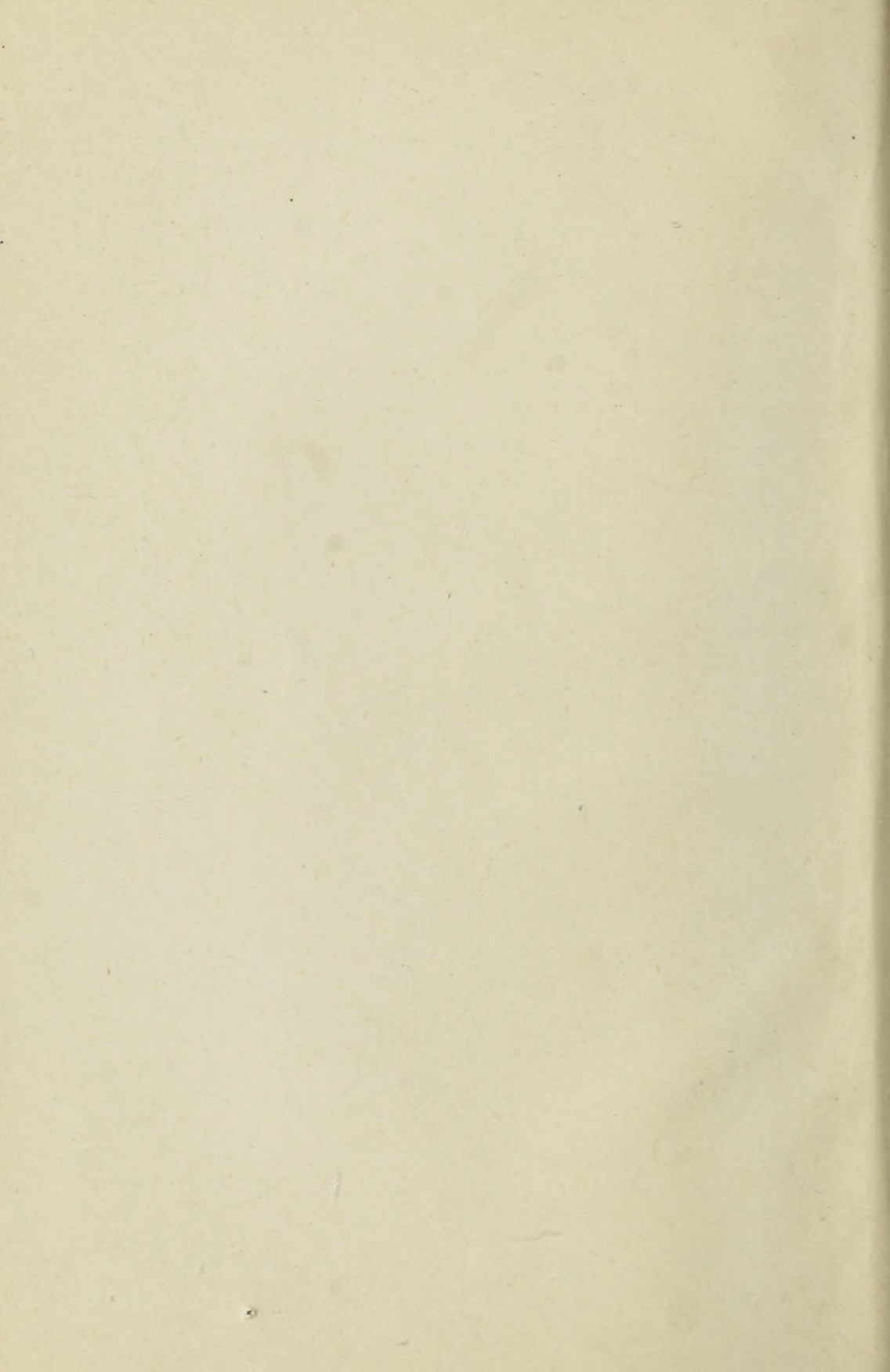






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OPERATIVE TECHNICS

MC GEHEE

OPERATIVE TECHNICS

A CONVENIENT REFERENCE AND MANUAL
FOR
PRACTITIONERS AND STUDENTS OF DENTISTRY

BY

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CLEVELAND DENTAL SOCIETY; HONORARY MEMBER OF THE
VIRGINIA AND TENNESSEE STATE DENTAL SOCIETIES

SECOND EDITION

ILLUSTRATED WITH 299 ENGRAVINGS

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DEDICATION

TO

HELEN NYE,

FAITHFUL AND LOVING WIFE, WHO, BY HER INFINITE
PATIENCE, INTELLIGENT COUNSEL, UNSELFISH
SACRIFICES AND UNFAILING INTEREST AND
DEVOTION, INSPIRES ALL HIS EFFORTS,
THIS BOOK IS DEDICATED BY HER
HUSBAND, *THE AUTHOR.*

PREFACE TO SECOND EDITION

The first edition of this work having been exhausted, the writer is enabled to comply with the numerous requests for a new edition that have been received from teachers and practitioners in the United States and abroad. During the past few years dentistry has made rapid and wonderful advancement, and the courses in the dental schools have been greatly enlarged, hence it has been deemed wise to re-arrange the subject matter and to enlarge the scope of the work to include the more recent thought and development in technical procedure.

New chapters have been added describing in full the technical details incident to the examination of the patient, exclusion of moisture, use of the matrix, separation of the teeth and similar procedures. The chapter on the treatment of vital and non-vital pulps has been considerably enlarged to include the recent advances in handling cases of this nature and an entire new chapter has been included on the diagnosis and treatment of diseases of the periapical tissues. The work has also been considerably enlarged by the addition of numerous illustrations including many original photographs, drawings, and radiographs.

A discussion of the causes and pathology of the various disease manifestations is not attempted to any extent in this book, as that phase of the subject is fully covered in books on dental pathology. The work therefore may be especially considered a technic manual for the busy practitioner and student.

The book was written primarily to fill a long-felt need for one that would suitably present the subjects of Dental Anatomy and Operative Technics for his own classes. Now, however, owing to the enlargement and wider scope the author believes it will also meet the needs of busy practitioners seeking knowledge in concise form, as well as those of teachers of the subject in other schools; relieving the latter of the tedium of culling from larger texts material for the preparation of lectures and aiding them in the mapping out of an adequate technic course.

The existence of two such excellent works on Dental Anatomy as those of Broomell-Fischelis and Black precludes the necessity for another, hence Dental Anatomy is confined to one chapter which may prove an aid to the teaching and study of one or the other of these books, as it outlines (which outline is the outcome of consultations with some of the most prominent teachers of the subject in this country), a technic course which has been modeled to suit the needs of the average student.

The technic exercises are the result of a study of the courses as taught in many of the prominent schools, and an experience of over twenty years as a teacher of the subject. They may be modified according to the judgment of the teacher to suit the needs of any classes.

The writer has freely consulted the most important works on modern Operative Dentistry and herewith acknowledges his indebtedness to their authors for material used. The perfection of our modern methods of operative procedure is the result of a gradual evolution in the thought and effort of many minds, hence, no great originality can be claimed for the subject matter in this volume—"Knowledge advances by steps and not by leaps and bounds."

The thanks of the author are extended to those friends and students who have so greatly assisted him in the illustrations, to the dental manufacturers who have kindly donated cuts illustrating their products, as well as to his publishers for their unremitting co-operation and interest. A number of the illustrations added to this edition were originally used in the writer's book, "Fundamentals of Operative Dentistry," to the publishers of which, Messrs. Ransom and Randolph Co., acknowledgment is herewith gratefully tendered for their permission.

If the work proves to be of assistance to teachers in outlining their courses, to the great body of young men yearly entering upon the study of a noble profession, and to practitioners of the science and art of dentistry, in acquiring a deeper knowledge of the subjects of Dental Anatomy and Operative Dentistry, the author will feel well repaid for the labor expended in its preparation.

CLEVELAND, OHIO.

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A TALK WITH THE STUDENT

"The greatest trust between man and man is the trust of giving counsel."—Francis Bacon.

"How to live, that is the essential question for us."—Herbert Spencer.

The following paragraphs are addressed primarily to those who are still students in the dental school. Those readers who have progressed beyond this stage and are now in active practice may well omit their perusal. It is felt that a few words of counsel to those young men and women who have recently entered the threshold of the profession are justifiable at this time, since the results to be accomplished in study, classroom, and laboratory depend largely on the attitude with which the subject is approached and on the ideals conceived and maintained during the college year.

Dear Student:

You are now engaged in the serious study of an elevated and noble profession, with your banner unfurled to the breeze and hope beating high in your breast. Advice from one who has passed through the same experiences which are soon to be yours should not be amiss.

You are now laying the foundations for your professional career. Let me urge you to place them deeply and broadly, in order that they may not totter and succumb under the weight of the superstructure which is to be raised upon them during the years to come. Your college life is the most important part of this architectural design. Your character is now in the process of formation, whether you will or no; habits are being formed, friendships are being made, which will influ-

ence your entire life. This being the case, it behooves you to pause with me for a few moments and consider the situation—to take a mental view of the landscape, which appears so bright and rosy and full of promise.

Let me urge you to be careful in selecting your social companions. You are probably now in a strange city, surrounded by many temptations, away from home restraints and the loving counsels of your parents, who, expecting much of you, have sent you forth into the world to fulfill your mission in life. Do not allow them to be disappointed. The care with which you choose your friends, the selection of the social circle in which you are to move, will greatly influence the development of your character and that personality which is to make or mar your future.

You should respect and endeavor to follow to the utmost the advice and teachings of your instructors. Make diligent effort to master the theoretical and technical studies with which you will be surrounded throughout your college course. Many students make the error of feeling satisfied if they have made a passing grade on theory and have more or less satisfactorily completed the requirements designated by the faculty of the school. You will make a serious mistake if you allow only this to be your aim, as you will fall far short of bringing out the best of your capabilities. Let me advise you to look at the matter from a much broader standpoint. Your chief aim should be to endeavor so to equip yourself for your life's work, and so to perfect yourself in your chosen profession, that you may be enabled to stand shoulder to shoulder with your future co-laborers, and intelligently serve those to whom you expect to minister.

Some are endowed with ambition to excel and stand above their fellows. Perhaps you, yourself, already have this idea, or have your thoughts fixed toward some prize which is

offered by your teacher. This is all very well, but the idea of *primarily* working for a prize or reward does not always stimulate to the best efforts. John Ruskin says: "A man or woman in private or public life, whoever works only for the sake of the reward which comes for the work will in the long run do poor work always. I do not care where the work is, the man or woman who does work worth doing is the man or woman who lives, breathes, and sleeps that work, with whom it is ever present in his or her soul; whose ambition it is to *do it well and feel rewarded by the thought of having done it well*. That man or woman puts the whole country under an obligation." Read the quotation again! The italics have been placed there by myself, because that is the important clause. *Do your work well*, not primarily for the sake of any pecuniary reward or attractive prominence which it may give you, but to *satisfy your own conscience*. Ralph Waldo Emerson means practically the same thing when he says: "Work in every hour, paid or unpaid, see that thou work and thou canst not escape the reward; whether thy work be fine or coarse, planting corn or writing epics, so only it be honest work, done to thine own approbation, it shall earn a reward to the senses as well as to the thought; no matter how often defeated, you are born to victory. The reward of a thing well done is to have done it."

I would impress upon you the broad scope and scientific nature of the profession which you are entering. The dentist is constantly working on living tissues which have an intimate relationship with all parts of the body. His work is founded on a thorough knowledge of Anatomy, Physiology, Chemistry, Materia Medica and Pathology, as well as on an understanding of physical and mechanical laws. He should at all times be prepared to write prescriptions for the treatment of oral diseases; he should be fully competent to make a

physical inspection of the heart and lungs, as well as an examination of the salivary and other secretions of the body; he should understand the administration of general and local anesthetics, his sense of the esthetic and artistic must be highly developed; and he must be prepared to do many other things of which you will learn later in your course. Do not imagine, then, that your chief functions are to be those of the artisan or mechanic. He who holds this narrow view of the profession and imagines that dentistry consists largely in the packing of a little gold or amalgam into a cavity in a tooth is wanting in knowledge.

In addition to perfecting yourself in a knowledge of dentistry I would advise that you devote a portion of your time to the acquirement of general information. There is nothing which has a more broadening influence than the reading of good literature. The man who knows nothing outside of his own calling soon degenerates and becomes small and narrow. The public expects the professional man to know something about everything, and will frequently place a low estimate on your ability, if you do not measure up to its expectations in this direction.

You should not only continue the pursuit of general and professional knowledge, but should also sedulously cultivate the habit of close observation and investigation. Learn how to exercise the faculty of thought and thus develop ideas of your own. "Read not to contradict and confute, nor to believe and take for granted, nor to find talk and discourse, but to weigh and consider. Some books are to be tasted, others to be swallowed and some few to be chewed and digested."—Lord Bacon.

Close attention to minutiae and detail are possibly of more importance in dentistry than in any other vocation. When one remembers the small size of the oral cavity and the many

minute and delicate operations which the dentist is constantly called upon to perform within this limited field, then only can one appreciate the importance of absolute exactness and attention to detail in the work. Each step of every operation should be made perfect before another is undertaken, if a perfect result is to be obtained. No part can be slighted or hurried. Make up your mind *now* never to let a piece of defective work go from your hands. Do it over and over again until you have done your *very best*. Your conscience is your best mentor in this, as in everything else.

Your constant aim should be perfection. Set the word **Perfection** up as your ideal and make it your daily endeavor to reach that ideal. He who constantly works with that end in view will make a success in his calling.

*“If a man can write a better Book—
Or preach a better Sermon—
Or make a better Mousetrap than his neighbor—
Though he build his house in the woods,
The world would make a beaten
Track to his door.”

And now, dear student, I could go on and on, but it is not necessary. If you will follow the precepts here laid down for your guidance you will never have cause for regret. With the hope that the following pages may be of interest and benefit, I will repeat to you the advice of Polonius to his son, who was leaving home for a journey into France:

Polonius: Yet here! Laertes! aboard, aboard, for shame!
The wind sits in the shoulder of your sail,
And you are stay'd for. There; my blessing with
thee!

*Attributed to Emerson, though not proven.

And these few precepts in thy memory
See thou character. Give thy thoughts no tongue,
Nor any unproportion'd thought his act.
Be thou familiar, but by no means vulgar.
Those friends thou hast, and their adoption tried,
Grapple them to thy soul with hoops of steel;
But do not dull thy palm with entertainment
Of each new-hatch'd, unfledged comrade. Beware
Of entrance to a quarrel, but being in,
Bear't that the opposed may beware of thee.
Give every man thy ear, but few thy voice;
Take each man's censure, but reserve thy judgment.
Costly thy habit as thy purse can buy,
But not express'd in fancy; rich, not gaudy;
For the apparel oft proclaims the man.
And they in France of the best rank and station
Are of a most select and generous chief in that.
Neither a borrower nor a lender be;
For loan oft loses both itself and friend,
And borrowing dulls the edge of husbandry.
This above all; to thine own self be true,
And it must follow, as the night the day,
Thou canst not then be false to any man.
Farewell; my blessing season this in thee!

(Hamlet, Act I., Scene III.)

OPERATIVE TECHNICS

CHAPTER I

DENTAL ANATOMY

HOW TO STUDY IT—HOW TO PERFORM THE TECH- NIC OPERATIONS—HOW TO REVIEW FOR EX- AMINATION

Text-books.—Dental Anatomy, Black; or Anatomy and Histology of the Mouth and Teeth, Broomell and Fischelis.

HOW TO STUDY THE SUBJECT

The study of Dental Anatomy will develop into an interesting and profitable pastime or a dull and lifeless labor, depending upon the standpoint from which its intricacies are approached. In a sense, it is really the foundation on which is to be built all dental knowledge, a thorough familiarity with the external and internal forms of the teeth, their points of interest and their intimate relationships with each other being absolutely essential to a complete understanding of the other branches of the curriculum. It has a direct bearing on all of these subjects, and the student should realize *now* that if he wishes to become proficient in the science and art of filling teeth, of making crowns, bridges and plates, and all of the procedures incident to the practice of dentistry, he should first learn this subject. In making the drawings, carving the blocks and filing the sections—in performing all the technic operations—he should do so *intelligently and thoroughly*, and with the view to deriving as much practical benefit as possible from

the procedures; else much of his time is being wasted and the work rapidly degenerates into uninteresting drudgery.

(The appended references refer to paragraph numbers in Black's Dental Anatomy, or to page numbers in the text or in Broomell and Fischelis' Anatomy and Histology of the Mouth



FIG. 1.—Occlusion of the teeth. Anterior view.

and Teeth. B. = Black; B.F. = Broomell and Fischelis; Par. = paragraph; pp. = page; fig. = figure.)

1. Study the Glossary of Black's Dental Anatomy. B. pp. IX-XVII.
2. Study the **names, number and arrangement** of the teeth, in the upper and lower jaw. B. par. 1, 2, 187 to 192. B.F. pp. 73, 74.

3. Study the general characteristics of the teeth and the form of the arch in the **sanguine, bilious, nervous and lymphatic** temperaments. *B. fig. 126, par. 187 to 188. B.F. pp. 77, 78, 83.*



FIG. 2.—Occlusion of the teeth. Lateral view.

4. Study the **occlusion** of the teeth (Figs. 1 and 2). *B. par. 190. B.F. pp. 85 to 90.*
5. Distinguish the difference between **occlusion** and **articulation**. *B.F. pp. 85 and 86.*
6. Distinguish between the **interproximal space** and the **interproximal embrasure**. *B. par. 13, 193 and 194.*

7. Study the **formula** for the permanent and deciduous teeth. *B. par. 2 and 128. B.F. pp. 75.*
8. Learn **Palmer's notation**. *Text pp. 9.*
9. Remember that the **gingival line** of Black and the **cervical line** of Broomell are the same. *B. par. 3. B.F. pp. 101.*



FIG. 3.—The upper arch.

10. Remember that Broomell calls the free margin of the gum the **gingival line**, while Black speaks of it as the **gingiva** or **gingival margin**. *B. par. 211, B.F. pp. 101.*
11. Study the **characteristics of the tissues** of which a tooth is composed. *B.F. pp. 72.*

12. Study and learn the definition of the parts of a tooth, such as **crown**, **root**, **neck**, **apex**, **pulp chamber**, **canals**, **apical foramen**; also the names of the **surfaces** and **angles**. *B. par. 3, 4, 5, 6, 7, 8. B.F. pp. 72 and 75.*
13. Study the difference between a **cusp** and a **tubercle**; a

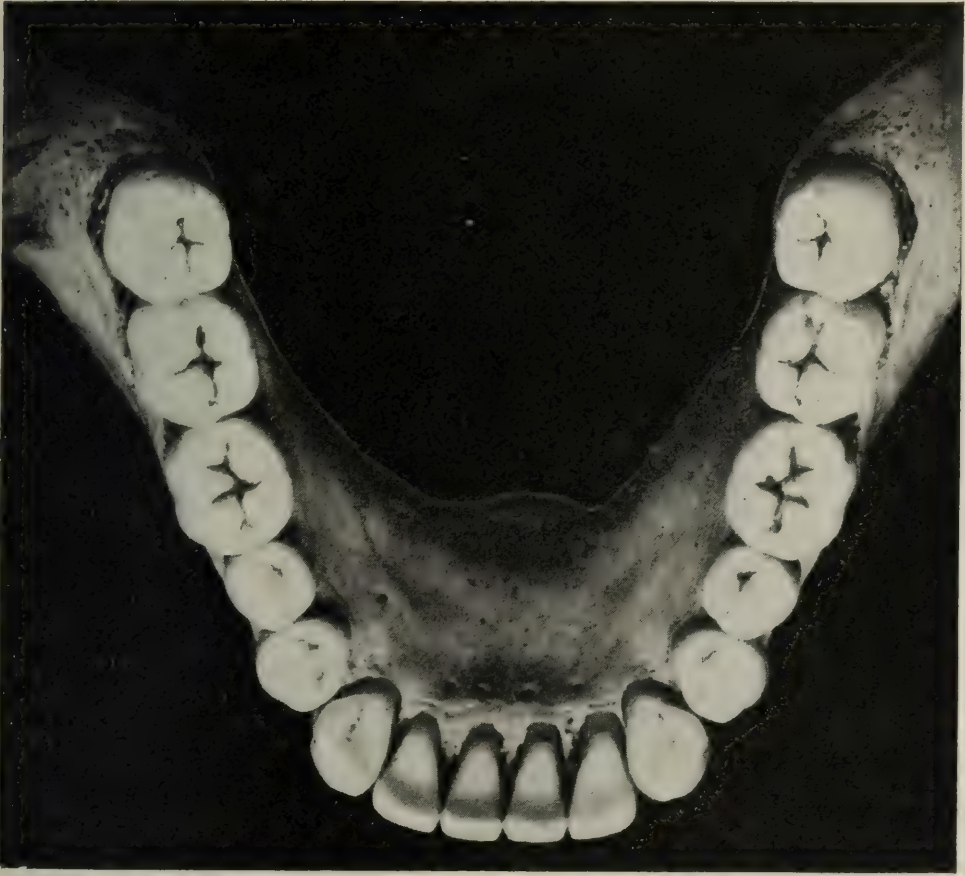


FIG. 4.—The lower arch.

- fossa**, **sulcus**, **groove**, and **fissure**. *B. Glossary. Also par. 8, 10, 11.*
14. Distinguish between the three varieties of **ridge**. *B. par. 9.*
15. Distinguish between the three varieties of **groove**. *B. par. 11 and 12.*
16. Study the relation of the **line of occlusion** to the **facial angle** (Figs. 5 and 6). *B.F. pp. 87 and 88.*

17. Study the difference between the **thick neck** and **bell-crown** teeth and the bearing of these on the shape of the interproximal space and the shape and size of the **contact point**. *B. par.* 14, 18, 194, 195. *B.F. pp.* 83.
18. Study the **method of attachment** of the teeth in the sockets. *B. par.* 196, 197, 206. *B.F. pp.* 73.

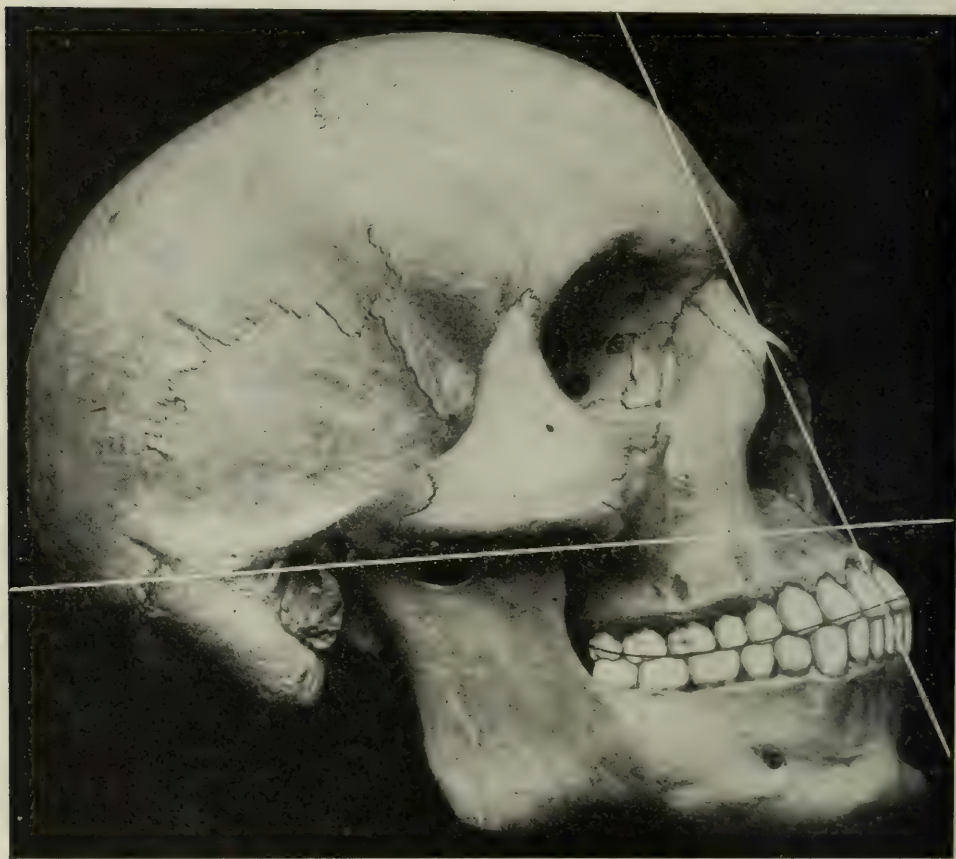


FIG. 5.—The facial angle and line of occlusion.

19. Study the **upper and lower incisors** as a group, noting differences in shape, size, location and inclination. *B. par.* 16 to 31, 191 to 192. *B.F. pp.* 110 to 124, 172 to 177—also 78, 79, 80, 81 and 82.
20. Study the surfaces, margins, angles, ridges, grooves and lobes of these.

21. Study the **upper and lower cuspids** in the same manner.
22. Study the **upper and lower bicuspid**s together in the same way.
23. Study the **molars**.



FIG. 6.—The compensating curve or the curve of Spee.

24. Study the differences between the **permanent and deciduous** teeth as to number, size, shape, color, length of roots, constriction of neck and inclination of buccal and lingual surfaces. *B. par.* 128 to 133. *B.F.* pp. 224, 225.
25. Study the anatomy of the **temporary first and second**

- molars**, upper and lower. *B. Par.* 129, 134 to 151. *B.F.* pp. 231 to 233, 236 to 238.
26. Study the form and size of the **pulp chamber and canals** in the permanent teeth while making the sections and prints in the technic course.
 27. Select from a miscellaneous lot the teeth of the various denominations.
 28. Study the form, location and size of the **contact points** on all of the teeth. *B. par.* 195. *Fig.* 132 to 136. *B.F.* pp. 84.
 29. Make the drawings and carvings of the teeth as outlined in the technic course, while studying their surface form.

HOW TO PERFORM THE TECHNIC OPERATIONS

Materials and Instruments Required

1. Note book (I. P., loose leaf, No. 9108, for memoranda and drawings).
2. Set of ivory or vegetable ivory blocks (Harper's, Tenney's or cut to order); or set of soap or French chalk blocks; or set of plaster-of-Paris blocks.
3. Wood blocks $1\frac{1}{4} \times \frac{3}{4} \times \frac{3}{4}$ inches.
4. Stick United States Express sealing wax.
5. Half dozen smooth broaches (round).
6. Half round, 10-inch file, bastard cut, medium coarse.
7. Bunsen burner and tubing, or alcohol lamp.
8. Small bench vise.
9. Mechanical saw frame, 12 saws.
10. Wax spatula.
11. Plaster bowl and spatula.
12. Plaster knife.
13. Vulcanite chisels.
14. Vulcanite scrapers.

15. Vulcanite file, half round.
16. Boley millimeter gauge.
17. Sheet fine sandpaper.
18. Nail brush and coarse cloth.
19. Blue pencil.
20. Operative chisels and excavators.
21. Ruled paper for prints.
22. Mouth blowpipe.
23. Wood modeling board and modeling tools.

The technic exercises in Dental Anatomy to be described consist of outline and shaded drawings of the surface form and internal anatomy of various teeth, modeling in clay, carving teeth in plaster, soap, French chalk and ivory, the sawing and filing of sections (showing the outline form of the pulp chamber and canals) and the making of prints or silhouettes from these sections. All of the exercises described may be modified to suit the needs of various classes, in the judgment of the teacher. The denomination and number of teeth to be selected will have to be regulated by the amount of time devoted to the work and whether all or only a part of the technical exercises here described are to be performed. The drawings, carvings, sections and prints, where necessary, should be annotated after Palmer's notation.

Palmer's Notation

Permanent teeth

8	7	6	5	4	3	2	1		1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	1		1	2	3	4	5	6	7	8

Deciduous teeth

V	IV	III	II	I		I	II	III	IV	V
V	IV	III	II	I		I	II	III	IV	V

The drawings and carvings should be done to Black's average measurements, natural size or enlarged as indicated, by means of a Boley millimeter gauge (Fig. 59).

Average Measurements of the Teeth, Taken from Black's Dental Anatomy

"The lines of measurement are:

1st. "Length over all": Length of the tooth from the cutting edge, or buccal cusp, to the apex of the root.

2nd. "Length of crown": Length of the crown from the cutting edge, or buccal cusp, to the gingival line on the labial or buccal surface.

3rd. "Length of root": Length of root from the gingival line on the buccal surface to the apex of the root.

4th. "Mesio-distal diameter of crown": This is the extent from mesial to distal in the greatest diameter, or at the points of proximate contact.

5th. "Mesio-distal diameter of neck": This measurement was made at the gingival line.

6th. "Labio- or bucco-lingual diameter": This measurement was taken at the greatest diameter of the crown in the direction named. In the incisors it was on the gingival ridge. In the bicuspid and molars it was generally mid-length of the crown, but occasionally it was near the gingival line, especially in the upper second and third molars.

7th. "Curvature of the gingival line": This is the height or extent of the curve of the gingival line toward the cutting edge, or occlusal surface, as it passes from labial to lingual, measured on the mesial surface."

UPPER TEETH

Table of Measurements of the teeth of man, given in millimeters and tenths of millimeters. UPPER TEETH	Length over all.	Length of crown.	Length of root.	Mesio- distal diam. of crown.	Mesio- distal diam. of neck.	Labio- or bucco- lingual diam.	Curvature of the gingival line.
Central Incisor. Average.	22.5	10.0	12.0	9.0	6.3	7.0	3.0
Lateral Incisor. Average.	22.0	8.8	13.0	6.4	4.4	6.0	2.8
Cuspid. Average.	26.5	9.5	17.3	7.6	5.2	8.0	2.5
First Bicuspid. Average.	20.6	8.2	12.4	7.2	4.9	9.1	1.1
Second Bicuspid. Average.	21.5	7.5	14.0	6.8	5.3	8.8	.8
First Molar. Average.	20.8	7.7	13.2	10.7	7.5	11.8	2.2
Second Molar. Average.	20.0	7.2	13.0	9.2	6.7	11.5	1.6
Third Molar. Average.	17.1	6.3	11.4	8.6	6.1	10.6	0.7

NOTE.—This table and the one on the following page are taken from Black's Dental Anatomy.

LOWER TEETH

Table of measurements of the teeth of man, given in millimeters and tenths of millimeters. LOWER TEETH	Length over all.	Length of crown.	Length of root.	Mesio-distal diam. of crown.	Mesio-distal diam. of neck.	Labio- or bucco-lingual diam.	Curvature of the gingival line.
Central Incisor. Average.	20.7	8.8	11.8	5.4	3.5	6.0	2.5
Lateral Incisor. Average.	21.1	9.6	12.7	5.9	3.8	6.4	2.5
Cuspid. Average.	25.6	10.3	15.3	6.9	5.2	7.9	2.9
First Bicuspid. Average.	21.6	7.8	14.0	6.9	4.7	7.7	0.8
Second Bicuspid. Average.	22.3	7.9	14.4	7.1	4.8	8.0	0.6
First Molar. Average.	21.0	7.7	13.2	11.2	8.5	10.3	1.1
Second Molar. Average.	19.8	6.9	12.9	10.7	8.1	10.1	0.2
Third Molar. Average.	18.5	6.7	11.8	10.7	8.3	9.8	0.2

Drawings

1. Outline the labial surface of the crown and root of 1 three times enlarged, according to Black's measurements, showing labial grooves, curvature of cervical line (gingival line of Black), shape of mesio- and disto-incisal angles. The root is conical in shape and the labial surface of the crown

NOTE.—The original drawings for the illustrations in this section were made by Doctor W. G. Pieck, Cincinnati, O.

irregularly square or trapezoidal. If the bases of a **pyramid** and a **trapezoid** are placed together, as in Fig. 7, the diagram may be made within.

2. Outline the mesial or distal surface of the crown and root of 1 three times enlarged, showing curvature of cervical

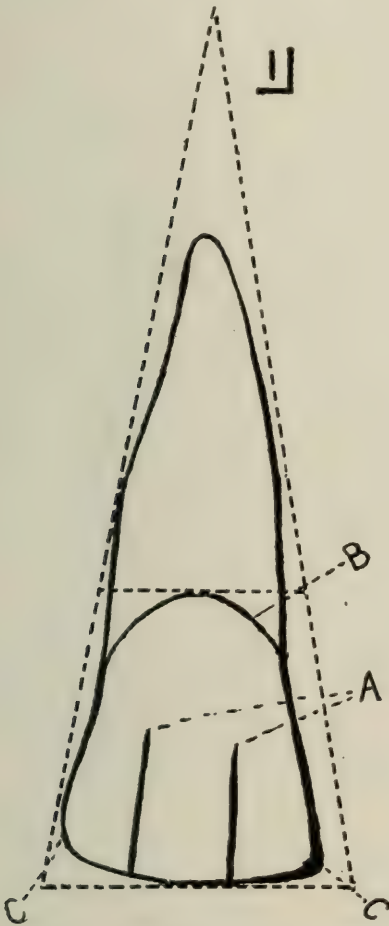


FIG. 7.—Right upper central incisor. Labial surface. *A*, labial grooves; *B*, curvature of cervical line; *C*, mesio and disto-incisal angles.

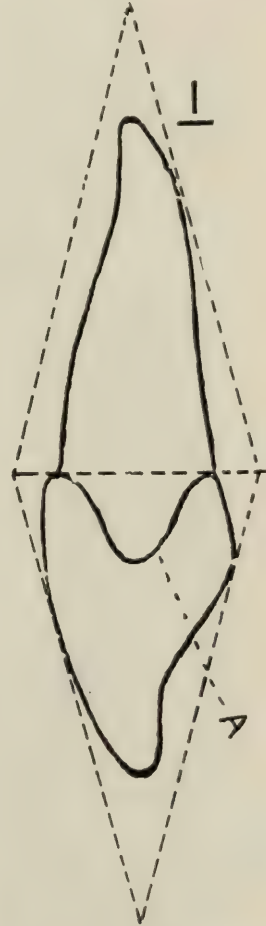


FIG. 8.—Upper central incisor. Mesial surface. *A*, Cervical line.

line (gingival line of Black). The proximal surfaces of the crown are wedge shape. Draw a **pyramid** and a **wedge** placed base to base, Fig. 8, and outline the tooth within.

NOTE.—All of the illustrations in this section are about three diameters with the exception of figures 17, 18, 22, 23, 24, 29, 30, 31, 32, 33.

3. Draw and shade a central incisor three times enlarged (Fig. 9).
4. Outline the labial surface of the crown and root of

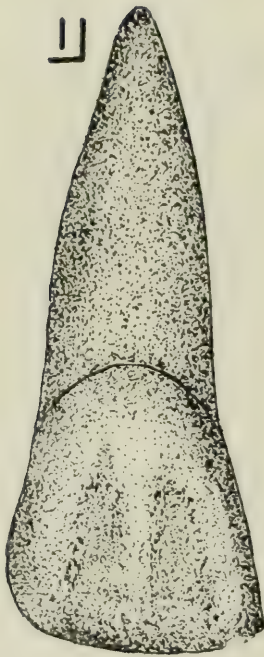


FIG. 9.—Right upper central incisor. Labial surface.

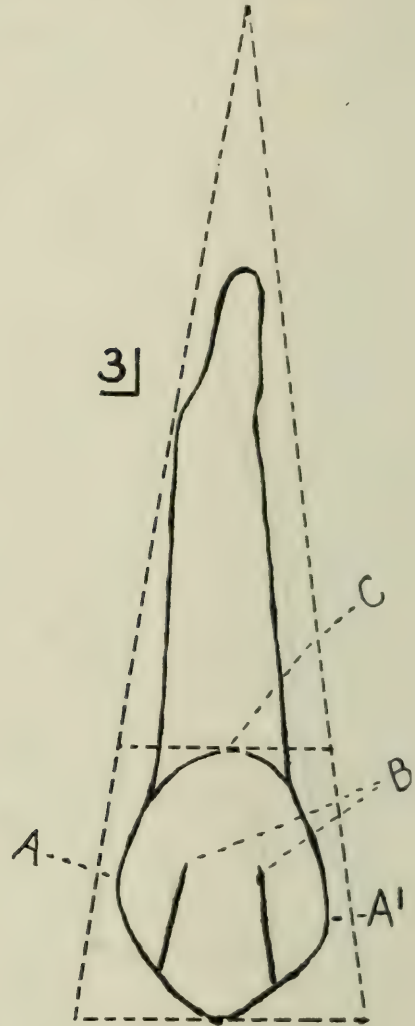


FIG. 10.—Right upper cuspid. Labial surface. *A*, Disto-incisal angle; *A'*, mesio-incisal angle; *B*, labial grooves; *C*, cervical line.

3 enlarged three times, in the same figure as indicated in No. 1, showing the location of the mesio- and disto-incisal angles, labial grooves, curvature of cervical line (gingival line of Black) (Fig. 10).

5. Draw and shade an upper cuspid (Fig. 11).

6. Outline the buccal surface of the crown and roots of 4, enlarged three times, in the same figure as before used, showing curvature of the cervical line (Broomell), location of angles, location of point of cusp to the *distal* and the buccal grooves (Fig. 12).



FIG. 11.—Right upper cuspid. Labial surface.

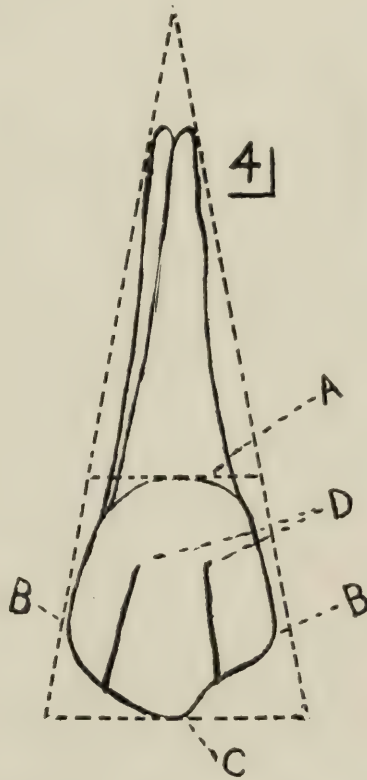


FIG. 12.—Right upper first bicuspid. Buccal surface. A, Cervical line; B, mesio- and disto-incisal angles; C, point of buccal cusp to the distal; D, buccal grooves.

7. Outline the mesial or distal surface of 4 showing two roots and curvature of cervical line (Broomell). The drawing may be made within a **parallelogram** and a **square**, placed base to base, Fig. 13.

8. Draw and shade an upper second bicuspid, showing the point of the buccal cusp to the *mesial* (Fig. 14).

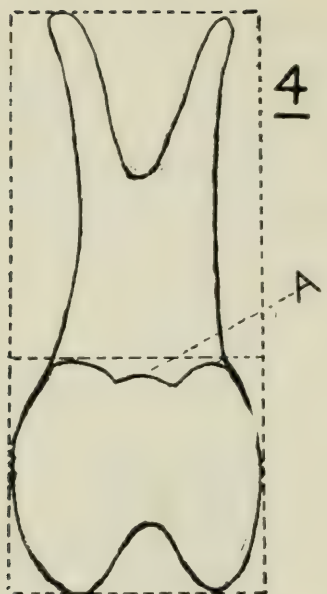


FIG. 13.—Upper first bicuspid. Mesial surface. A, Cervical line.

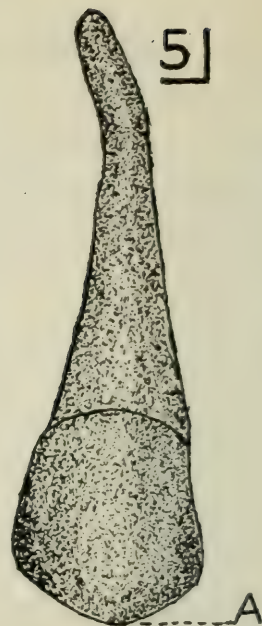


FIG. 14.—Right upper second bicuspid. Buccal surface. A, Buccal cusp.

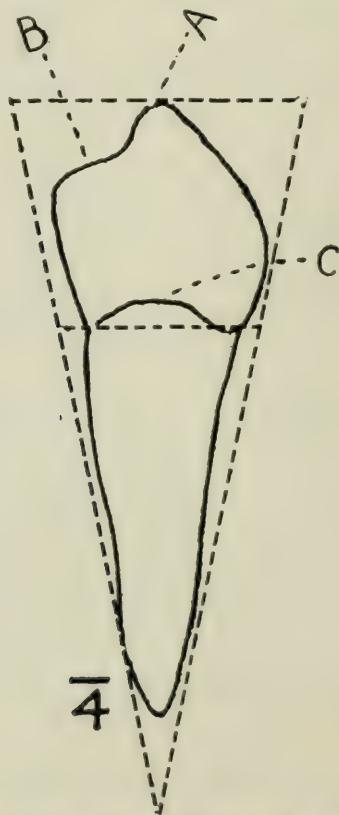


FIG. 15.—Lower first bicuspid. Mesial surface. A, Buccal cusp; B, lingual cusp; C, cervical line.

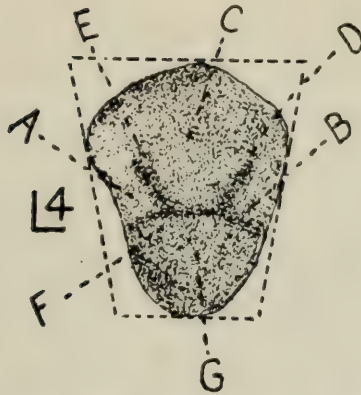


FIG. 16.—Left upper first bicuspid. Occlusal surface. *A*, Mesial marginal ridge; *B*, distal marginal ridge; *C*, buccal triangular ridge; *D*, *E*, triangular grooves; *F*, central groove; *G*, lingual triangular ridge.

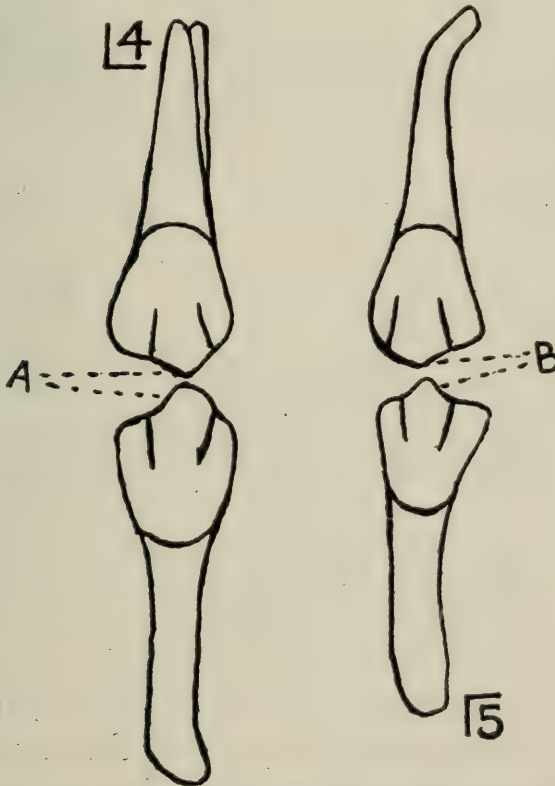


FIG. 17.—Left upper and lower first and second bicuspids. *A*, Points of cusps of first bicuspids nearer to the distal. *B*, Points of cusps of second bicuspids to the mesial.

9. Outline the mesial or distal surface of $\overline{4}$ within a figure as indicated in No. 1 *reversed*, showing relative size of buccal and lingual cusps and curvature of cervical line (Fig. 15).

10. Draw the occlusal surface of $\underline{4}$, three times enlarged, indicating the location of the ridges and grooves by initials on the drawing. Make the drawing within a figure of **trapezoidal** or **keystone shape** (Fig. 16).

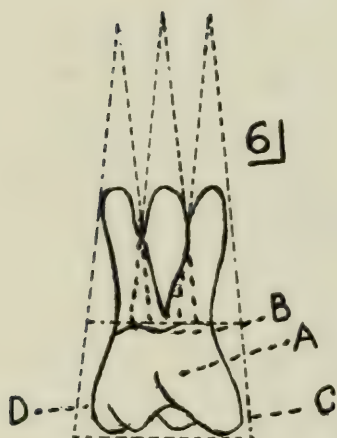


FIG. 18.—Right upper first molar. Buccal surface. *A*, Buccal groove; *B*, cervical line; *C*, mesio-bucco-occlusal angle; *D*, disto-lingual cusp.

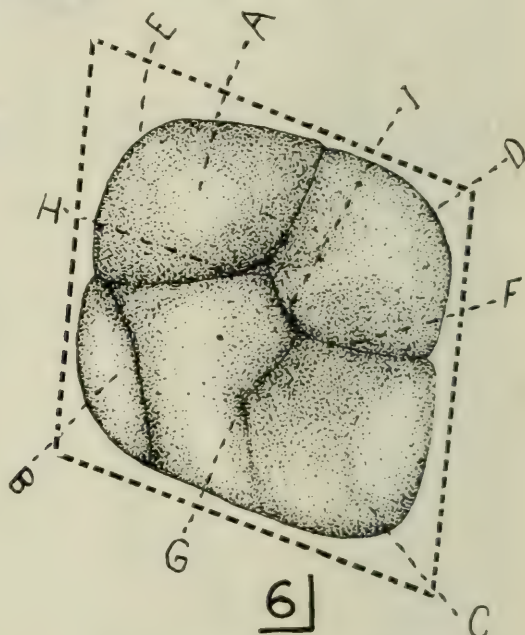


FIG. 19.—Right upper first molar. Occlusal surface. *A*, Disto-lingual cusp; *B*, fifth cusp; *C*, mesio-buccal cusp; *D*, disto-buccal cusp; *E*, disto-lingual angle; *F*, buccal groove; *G*, mesial groove; *H*, disto-lingual groove; *I*, distal groove.

11. Make a drawing showing the location of points of the buccal cusps of $\underline{4}$, $\underline{5}$ and $\overline{4}$, $\overline{5}$. According to Black's Dental Anatomy they are most frequently located as follows, viz.:

Upper first bicuspid, point of the cusp to the distal.

Upper second bicuspid, point of the cusp to the mesial.

Lower first bicuspid, point of the cusp to the distal.

Lower second bicuspid, point of the cusp to the mesial.

This does not obtain in many instances (Fig. 17).

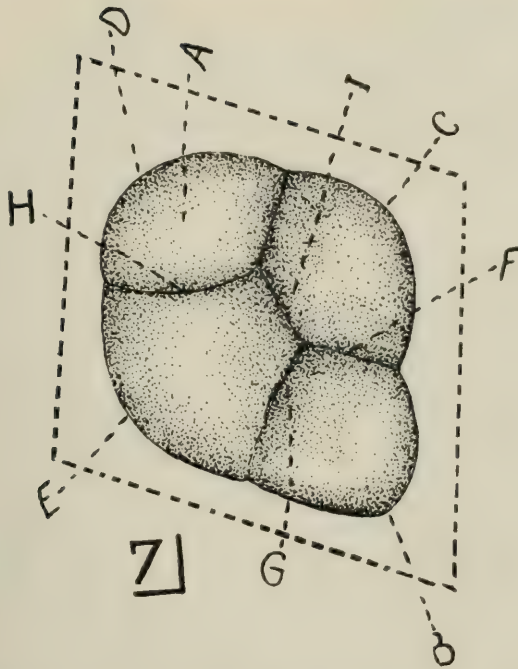


FIG. 20.—Right upper second molar. Occlusal surface. *A*, Disto-lingual cusp; *B*, mesio-buccal angle; *C*, disto-buccal angle; *D*, disto-lingual angle; *E*, mesio-lingual angle; *F*, buccal groove; *G*, mesial groove; *H*, disto-lingual groove; *I*, distal groove.

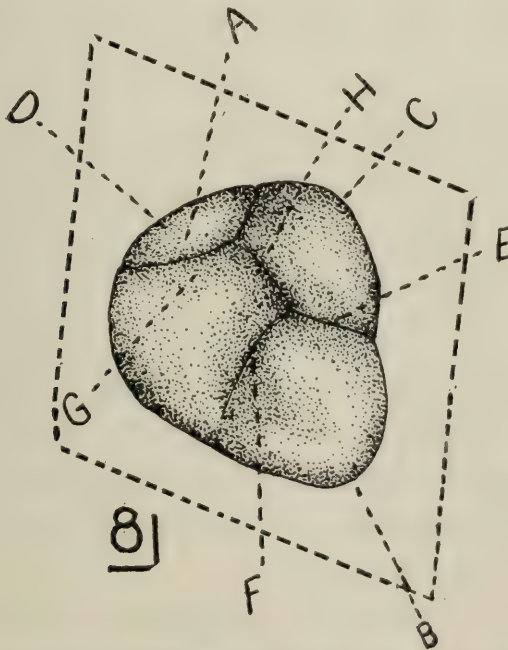


FIG. 21.—Right upper third molar. Occlusal surface. *A*, Disto-lingual cusp; *B*, mesio-buccal angle; *C*, disto-buccal angle; *D*, disto-lingual angle; *E*, buccal groove; *F*, mesial groove; *G*, mesio-lingual cusp; *H*, distal groove.

12. Outline a figure (Fig. 18) consisting of three **pyramids** and a **trapezoid**, placed base to base, and draw the buccal aspect of 6 showing three roots, buccal groove, curvature of the cervical line and location of the mesio- and disto-bucco-occlusal angles.

13. The shape of the occlusal surfaces of 6, 7, 8 is irregularly **rhombic** (Figs. 19, 20, 21). Draw three such figures and outline the occlusal surface of 6, 7, 8 one in each, showing differences in general shape of the surfaces of the three, the

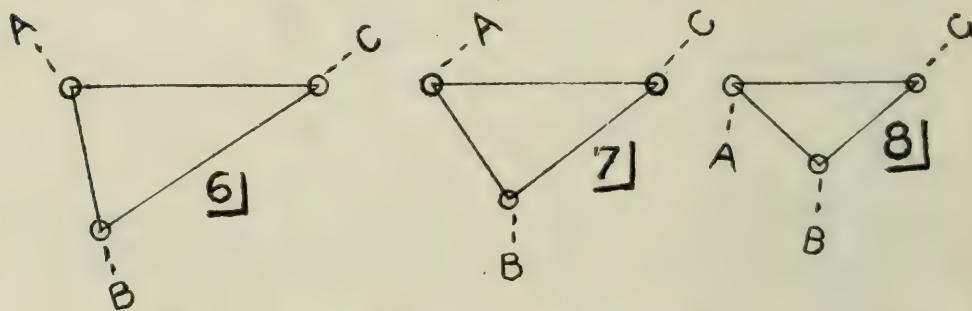


FIG. 22.—The molar triangle. Right upper first, second and third molars. *A* Entrance to mesio-buccal canal; *B*, entrance to disto-buccal canal; *C*, entrance to lingual canal.

difference in size of the disto-lingual lobe, location of the fifth cusp on 6 and shape of the angles. Indicate by letters the ridges, fossæ, lobes and grooves.

14. The entrance to the canals on the floor of the pulp chambers of upper molars is situated at the corners of an imaginary triangle known as the **Molar Triangle** (Fig. 22). Draw three triangles, one to represent each upper molar, right side, showing the difference in the shape and size of the triangles, due to diminution in the size of the teeth and change of location of the disto-buccal canal. Indicate by letters on the drawings the location of each individual canal.

15. Draw three cubical figures and place the mesial and distal roots of a lower molar at their bases (Fig. 23). Indicate

by letters the location of the surfaces, margins, line and point angles of a lower molar.

16. Draw and shade the buccal surface of $\overline{6}$ and $\overline{7}$, showing crown and roots (Figs. 24 and 25).

17. Draw and shade the mesial surface of crown and roots of $\overline{6}$ (Fig. 26).

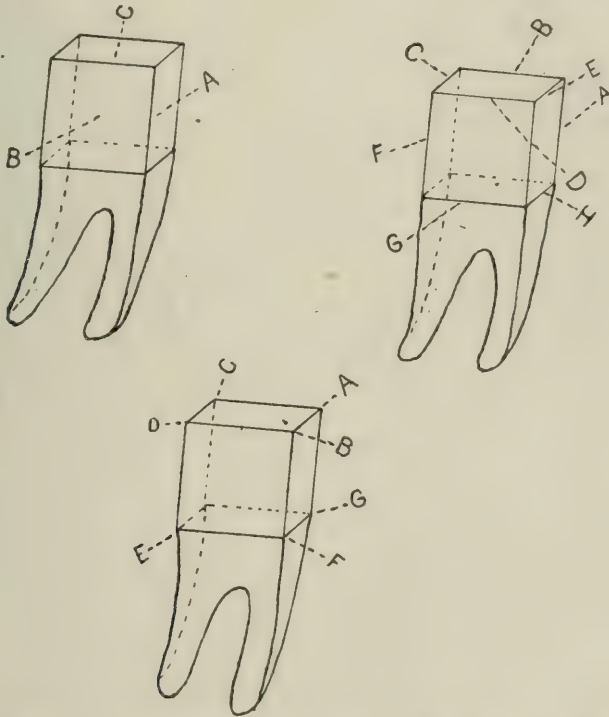


FIG. 23.—Diagrammatic drawing to show the surfaces and line and point angles on lower molars.

FIRST DIAGRAM.—*A*, Mesial surface; *B*, buccal surface; *C*, occlusal surface.

SECOND DIAGRAM.—*Line angles*. *A*, Mesio-lingual angle; *B*, occluso-lingual angle; *C*, disto-occlusal angle; *D*, bucco-occlusal angle; *E*, mesio-occlusal angle; *F*, disto-buccal angle; *G*, *H*, gingival line.

THIRD DIAGRAM.—*Point angles*. *A*, Mesio-linguo-occlusal; *B*, mesio-bucco-occlusal; *C*, Disto-linguo-occlusal; *D*, disto-bucco-occlusal; *E*, disto-bucco-lingual; *F*, mesio-bucco-lingual; *G*, mesio-linguo-lingual point angles.

18. Draw a **trapezoidal** figure, Fig. 27, and outline occlusal surface of $\overline{6}$, indicating location of the ridges, grooves and lobes.

19. Draw a **parallelogram**, Fig. 28, and outline the occlusal surface of $\overline{7}$, indicating the location of the ridges, grooves and lobes.

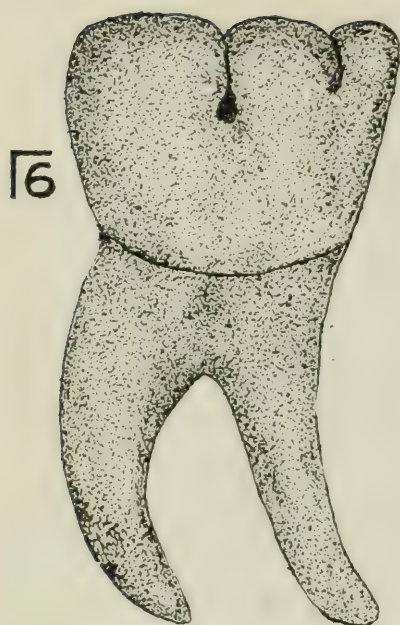


FIG. 24.—Left lower first molar.
Buccal surface.



FIG. 25.—Left lower second molar.
Buccal surface.



FIG. 26.—Left lower first molar. Mesial surface.

20. Draw the teeth of the upper and lower jaw in OCCLUSION, showing correct curvature of the line of occlusion, with its lowest point at the proper location, natural size (Fig. 29).

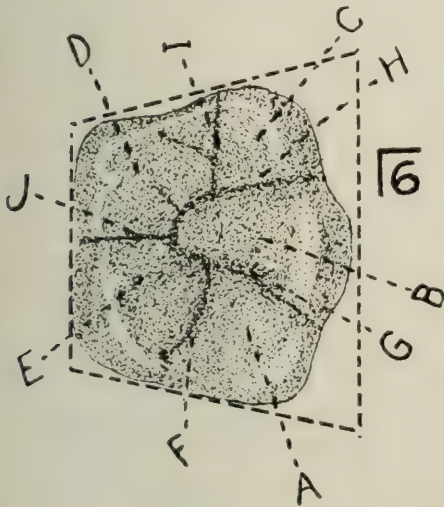


FIG. 27.—Left lower first molar. Occlusal surface. *A*, Mesio-buccal triangular ridge; *B*, disto-buccal triangular ridge; *C*, distal triangular ridge; *D*, disto-lingual triangular ridge; *E*, mesio-lingual triangular ridge; *F*, mesial groove; *G*, mesio-buccal groove; *H*, disto-buccal groove; *I*, distal groove; *J*, lingual groove.

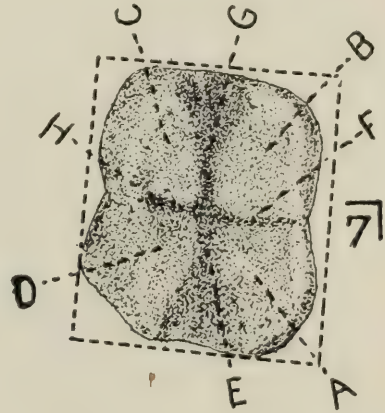


FIG. 28.—Right lower second molar. Occlusal surface. *A*, Mesio-lingual lobe; *B*, disto-lingual lobe; *C*, disto-buccal lobe; *D*, mesio-buccal lobe; *E*, mesial groove; *F*, lingual groove; *G*, distal groove; *H*, buccal groove.

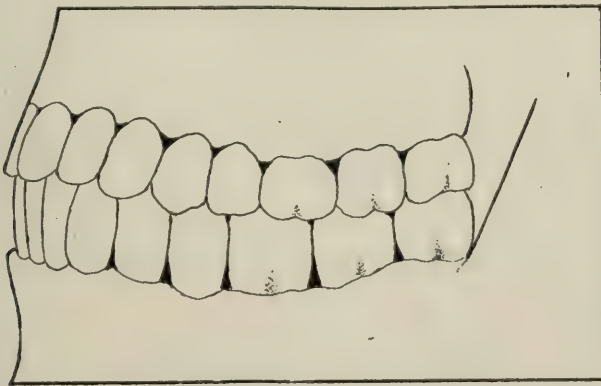


FIG. 29.—Occlusion of the teeth of the left side.

21. Make a drawing, side view, showing the proper inclination of the upper and lower anterior teeth (Fig. 30). The

uppers have a **labial** inclination, the lowers have a **slight labial** inclination or are occasionally **perpendicular**.

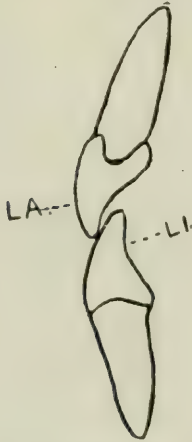


FIG. 30.—Inclination of the anterior teeth. Side view.



FIG. 31.—Mesial inclination of the upper central incisors.

22. Make a drawing, labial view, showing **mesial** inclination of these teeth (Fig. 31).

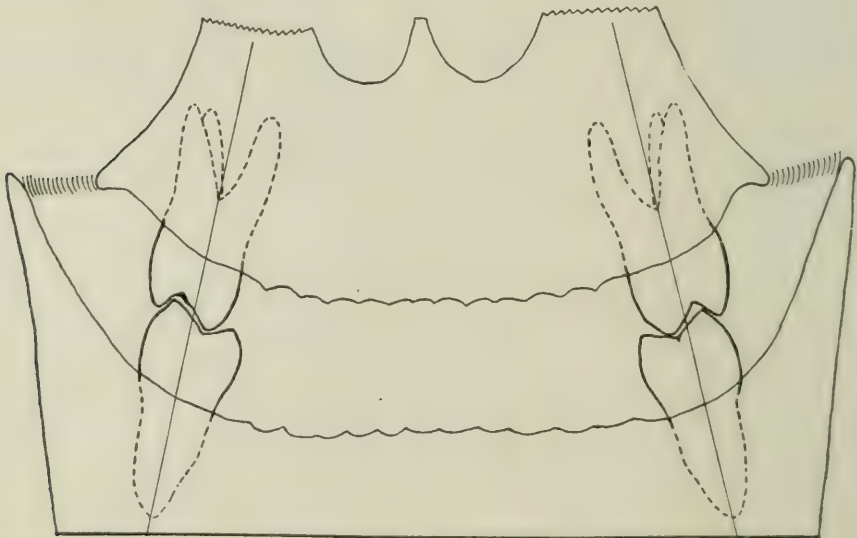


FIG. 32.—Diagrammatic drawing showing buccal inclination of the upper molars and lingual inclination of the lower molars.

23. Make a drawing, mesial view, showing general **buccal** inclination of the upper bicuspid and molars and general

lingual inclination of the lower teeth of the same denomination (Fig. 32).

24. Make a drawing of a longitudinal section of a central incisor, showing the enamel, dentin, cementum and pulp (Fig. 33).



FIG. 33.—Upper central incisor. Proximal surface. A, Enamel; B, dentin; C, cementum; D, pulp. (Diagrammatic.)

Modeling in Clay

The teeth are to be modeled to Black's measurements, enlarged five times. The rough molding to form is first done on the modeling board with the hands, when the finer

details are then brought out by means of the modeling tools. A natural tooth in front of the student serves as a guide.

Carving Teeth in Plaster

The denomination of the teeth and the number to be carved will be regulated by the time at the disposal of the student, in the discretion of the teacher. The technic of carving is practically the same as that described for *ivory teeth* and the student is referred to that section (page 27). The teeth are to be carved from plaster blocks to Black's average measurements, multiplied five times. The entire root should be carved. These teeth may be used later for technic work in cavity preparation.

Carving Teeth in Soap

The best soap for the purpose is Procter and Gamble's Ivory soap. This should be cut in blocks of proper dimensions, and laid out for hardening or seasoning for two weeks previous to the carving, otherwise it is too soft.

Carve all the teeth natural size, upper and lower of one side. The cuttings are made with a knife and wax spatula, the finer carving being done with the excavator or small chisel. The final polish may be put on by gently rubbing with the finger. The technic is the same as given under "Carving in Ivory," except that the cuttings are done with a knife, wax spatula, chisel and excavator.

Carving Teeth in French Chalk

French Chalk.—Synonyms, Soap-stone, Talc, Steatite.
—Chemical composition, magnesium silicate.

Excellent carvings may be made from this material, which is of an olive-green, grayish or white color and easily obtained from drug-supply houses. The white variety is best for this purpose. It is readily sawed into blocks of convenient size and carved according to the technic given for carving in ivory. Its cutting consistence is much softer than ivory and harder than soap. The same instruments are used, the final polish being put on by rubbing with a smooth cloth.

Carving Teeth in Ivory

Ivory or bone blocks may be obtained for this purpose from the S. S. White Dental Mfg. Co., the Wenker Dental Mfg. Co. and Armour & Sons. Dr. Harper's, a set of six blocks, and Dr. Tenney's, a set of four, are also available. *Vegetable* ivory blocks are used as a substitute in some schools. They are not so hard as the ivory or bone block, and may be still further softened by saturation in water. The teeth to be carved are to be decided by the teacher.

Directions for Carving

Select a well-formed natural tooth. This is to serve only as a guide in the carving and not to be duplicated. The ivory carving is made to Black's measurements, with the *millimeter gauge* and on completion should be within 0.5 mm. of Black's measurements. For the lines of measurement, see page 10.

1. **Central Incisor.**—The instructions for carving the central will serve for any of the anterior teeth.

(a) With a blue pencil or ink, mark on the block the location, taken by means of the Boley gauge, of the future *contact points*, allowing 0.5 mm. excess for finishing down.

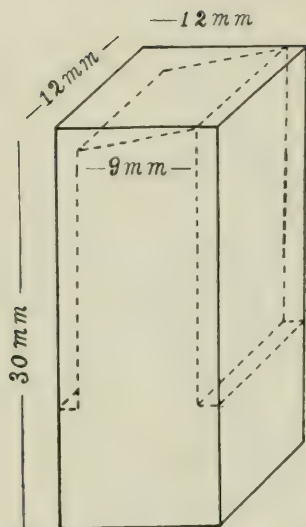


FIG. 34.—Marking and sawing the block to the future contact points and giving it the general slope of the cutting edge. Labial surface. The illustrations are not to scale.

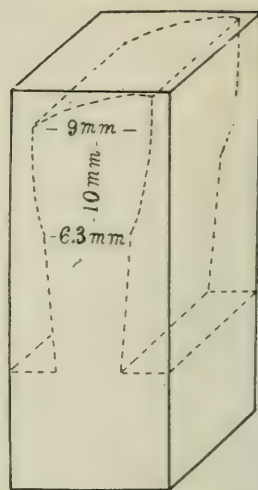


FIG. 35.—Outlining the cutting edge; measuring the length of the crown and the mesio-distal diameter at the neck; outlining the convexity of the proximal surfaces, filing to these marks and blocking out the root.

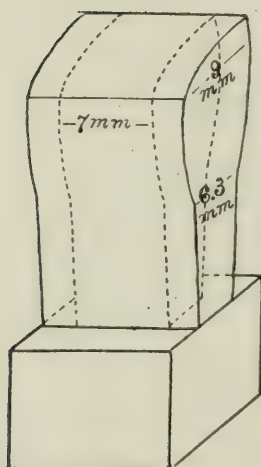


FIG. 36.—Taking the measurement for the greatest labio-lingual diameter and sawing the block to this dimension. Proximal surface.

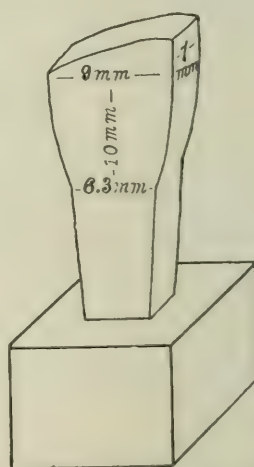


FIG. 37.—Block gradually assuming proper form.

(b) Saw the block down to these points.

(c) With the blue pencil, outline the future *cutting edge*

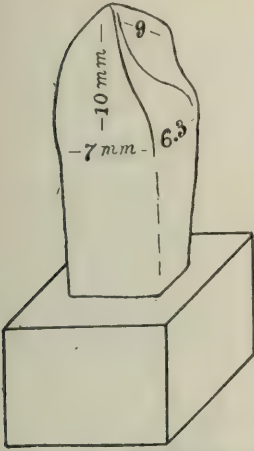


FIG. 38.—Filing the block on the mesial and distal sides to proper curvature of the labial and lingual surfaces.

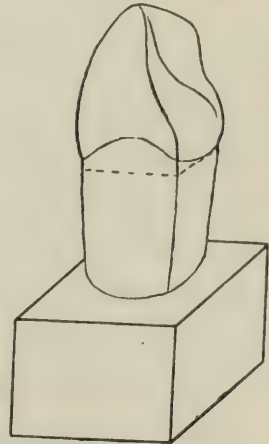
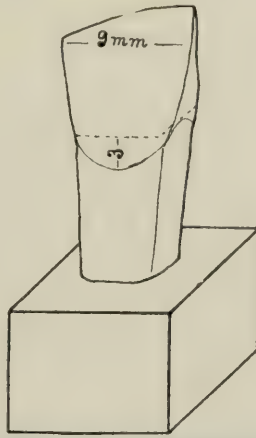


FIG. 39.—Outlining the curvature of the cervical line. Labial and proximal view.

with its proper slope toward the disto-incisal angle, and with the saw and vulcanite file trim the block nearly to this line, allowing 0.5 mm. excess for finishing (Fig. 34).

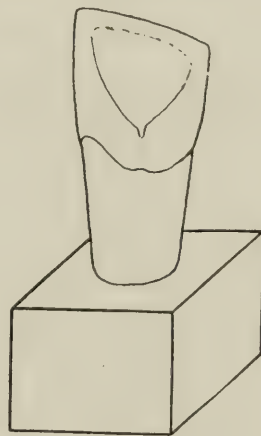
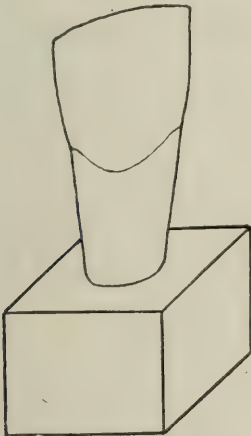


FIG. 40.—Carving complete. Labial and lingual view.

(d) With the millimeter gauge, measure the *length of the crown* from the cutting edge to the future cervical line on the

NOTE.—The drawings illustrating the method of carving were made by Doctor E. W. Niederhofer, Cincinnati, O.

labial surface, and mark the location of the cervical line (gingival, Black) with the pencil.

(e) Mark the location, taken by means of the Boley gauge, of the future *mesio-distal diameter of the neck* of the tooth. Then outline the *convexity of the mesial and distal surfaces* by drawing a line from the contact points to these marks.

(f) With the file trim the blocks on the mesial and distal sides nearly to the marks made in "e," giving these sides the proper convexity, *the distal side being more convex*. The cuttings may be carried a distance of half way up the future root of the tooth (Fig. 35).

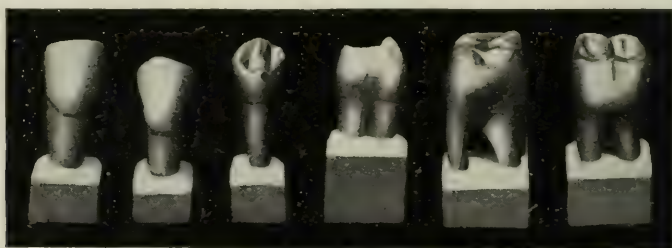


FIG. 41.—Carvings in ivory.

(g) With the Boley gauge take the measurement for the greatest *labio-lingual* diameter, which will be at the gingival ridge, and mark it on the mesial and distal sides of the block (Figs. 36 and 37).

(h) Now, holding the block on its mesial or distal side, outline with the pencil the *curvature of the labial and lingual surface* from the cutting edge to the cervical line.

(i) File to shape, carrying the labial and lingual cuttings a distance of half way up the future root. The apical half or third of the root is not carved, leaving the end of the block untouched (Fig. 38).

(j) To outline the *curvature of the cervical line*, find the proper measurement from the "Table of Measurements" and mark the length of curvature by means of the millimeter gauge

on the labial surface; then draw a straight line from this point to the mesial and distal surfaces, which will then give the extent of the curvature (Fig. 39).

(k) Bring all the cuttings down to proper measurement, and do the finer carving with the file, scraper and small chisels and excavators, representing the marginal and gingival ridges, grooves, cervical line and all other points (Fig. 40).

(l) Finish with sandpaper of increasing fineness, and then with pumice and whiting on the lathe (Fig. 41).

2. **Bicuspid and Molar.**—Practically the same directions are followed. First mark the contact points and saw or trim not quite to them. Repeat the same procedure for the buccolingual diameter. Then measure for the length of the crown on the buccal, lingual, mesial and distal sides, after which outline with the pencil the proper contours and saw or file to them, finally extending the cuttings the desired length and shape. Then complete the surface markings, such as ridges, grooves and cusps, as well as the cervical line, with the scraper and chisels and excavators, completing the work with sandpaper, pumice and whiting.

If desired and time permits, the teeth of the upper and lower jaw, right or left side, may be carved and then mounted in occlusion on hard or soft rubber jaws. If this is done, all the teeth should be modeled after a definite type, as sanguine, bilious, nervous or lymphatic. They may then be later used for the technic exercises in cavity preparation.

Sawing and Filing Sections

The **object** of cutting sections is to give the student familiarity with the cutting consistence of natural tooth structure, to familiarize him with the thickness of enamel, dentin and cementum, together with their relations to each other, and to expose the pulp chamber and canals for purposes of study.

1. **Longitudinal Sections.**—Make one section by means of the file from the labial, buccal or lingual, and one from the mesial or distal aspect of the teeth selected by the teacher.

2. **Transverse Sections.**—Make by means of the saw a transverse section at the cervical line and another at mid-root of the upper and lower teeth selected.

Directions.—(1) *For the Longitudinal Sections.*—(a) Fix the tooth on the wood block by means of melted sealing wax

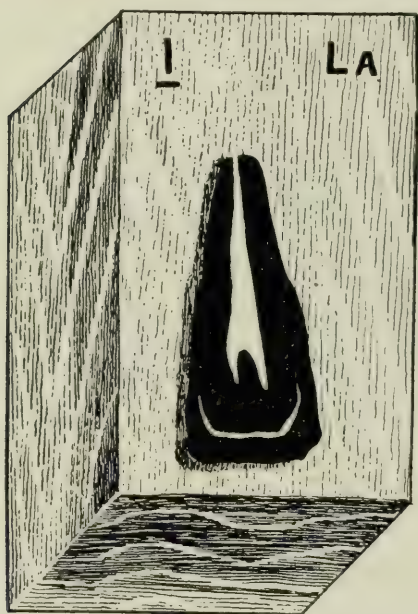


FIG. 42.—Longitudinal section of the upper central incisor, labial aspect, mounted and annotated.

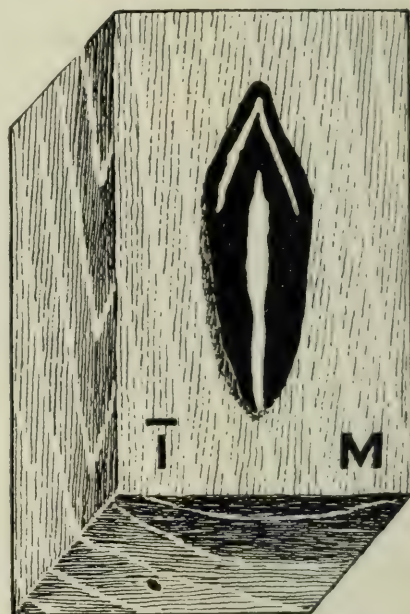


FIG. 43.—Longitudinal section of the lower central incisor, mesial aspect, mounted and annotated.

and a wax spatula. For sections showing the **labial** or **buccal** aspect of the chamber and canals, mount the tooth with the **lingual** surface facing up. For those showing the **mesial** or **distal** aspect, mount the *opposite* surface facing up. (b) Fix the block securely in the bench vise and file longitudinally at an angle of 45 degrees until the pulp chamber is exposed. (c) Then insert a smooth broach into the chamber and carry it the full length of the canal through the apical foramen. File until

the broach is exposed full length. Then, removing the broach, clear out the contents of the chamber and canals and render clean and smooth so that a good clear-cut print may be made later (Figs. 42 and 43).

(c) *Transverse Sections*.—(a) Mount the tooth longitudinally on the block by means of sealing wax. (b) Fix in the vise, and, with the saw, make a transverse section at the neck

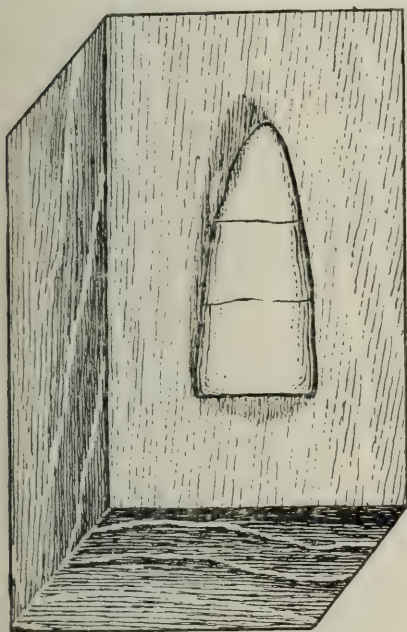


FIG. 44.—Tooth mounted on a wood block and sawed into three sections.

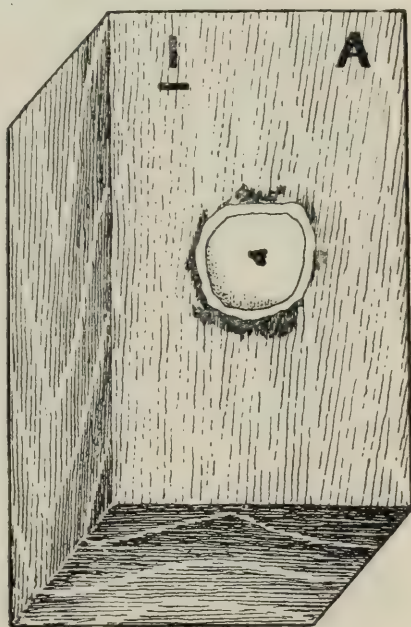


FIG. 45.—Gingival section of an upper central incisor, mounted and annotated.

and another at mid-root, thus cutting the tooth into three sections. (c) Clear out the contents of the chamber and canals with broaches and excavators, rendering the margins distinct and clear for making prints later (Figs. 44, 45, 46, and 47).

(b) *Mounting the Sections*.—Mount the section permanently on the block by covering the face of the block with melted sealing wax, building it up so as to elevate the section from the block if so desired. Smooth the wax with a spatula

and put on a high, smooth finish with a mouth blowpipe. The margins of the section should extend slightly above the level of the sealing wax so as not to interfere later with the making of a good print.

(e) *Cutting the Relief Line.*—With a small wheel bur or chisel cut a relief line on the longitudinal section at the junction of the enamel and dentin, removing the *stratum*

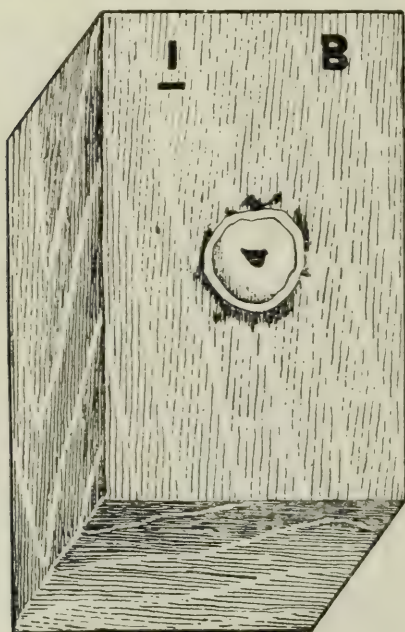


FIG. 46.—Mid-root section of an upper central incisor, mounted and annotated.

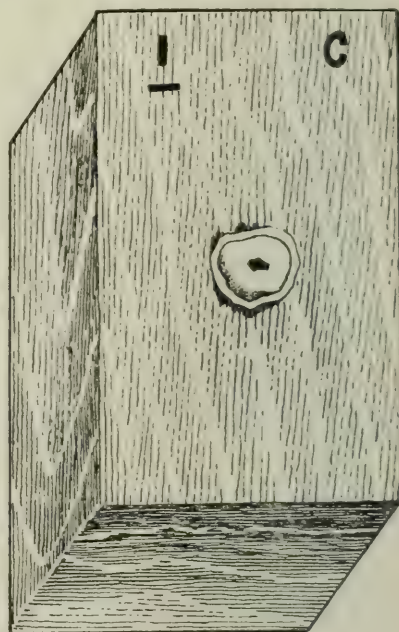


FIG. 47.—Apical third section of the upper central incisor.

granulosum and thus bringing out the thickness of the enamel cap.

(f) *Finishing.*—Smooth the entire exposed surface of all the sections with fine sandpaper.

(g) *Labeling or Annotating the Sections.*—For the upper *longitudinal* sections, mark the notation, as 1, 2, 3 in the upper *left-hand corner* and the aspect presenting to view as La., Li., Bu., in the upper *right-hand corner* (Fig. 42). For the lowers place them in the *lower* left- and right-hand corners



FIG. 48.—A method of mounting and annotating a box of fifty-six longitudinal and transverse sections. The face of the wood block is covered with sealing wax, which is modeled to form with a wax spatula and polished by heating with a mouth blowpipe.

respectively (Fig. 43). In this way the denomination of the tooth and the aspect presenting to view may be seen at a glance. For the transverse sections the same plan is followed in regard to the denomination of the tooth. Also label the block in the upper or lower right-hand corner, depending on whether the tooth is upper or lower, A, B, or C, thus indicating whether it is the *crown*, *mid-root* or *apical* section; A representing the crown, B the mid-root, and C the apical portion (Figs. 45, 46, 47).

Making Prints or Silhouettes

Object.—To further impress upon the student's mind the size, location and shape of the pulp chamber and canals, the outline form of the tooth and the relative thickness of the enamel and dentin.

Directions.—The prints are made on ruled paper, as in the illustration, Fig. 49, from the sections already made. The face of the section must be perfectly smooth and the enamel line and chamber and canal margins clearly cut, if good prints are desired.

(a) Ink the surface of the section by bringing it in contact with the ink pad. Avoid too much ink.

(b) Stamp the section firmly in contact with the note paper, and hold steadily for a few moments to allow the ink to take hold of the paper. In *curved sections* great care is necessary to bring every portion of the section in contact with the paper. Several thicknesses of the paper may be held in the palm of the left hand while stamping with the right hand; or laying the paper on a soft rubber pad of about $\frac{1}{4}$ inch in thickness and carefully rotating the section longitudinally is a valuable procedure in these cases.

(c) Annotate the prints in the same manner as described for the sections (Fig. 49).

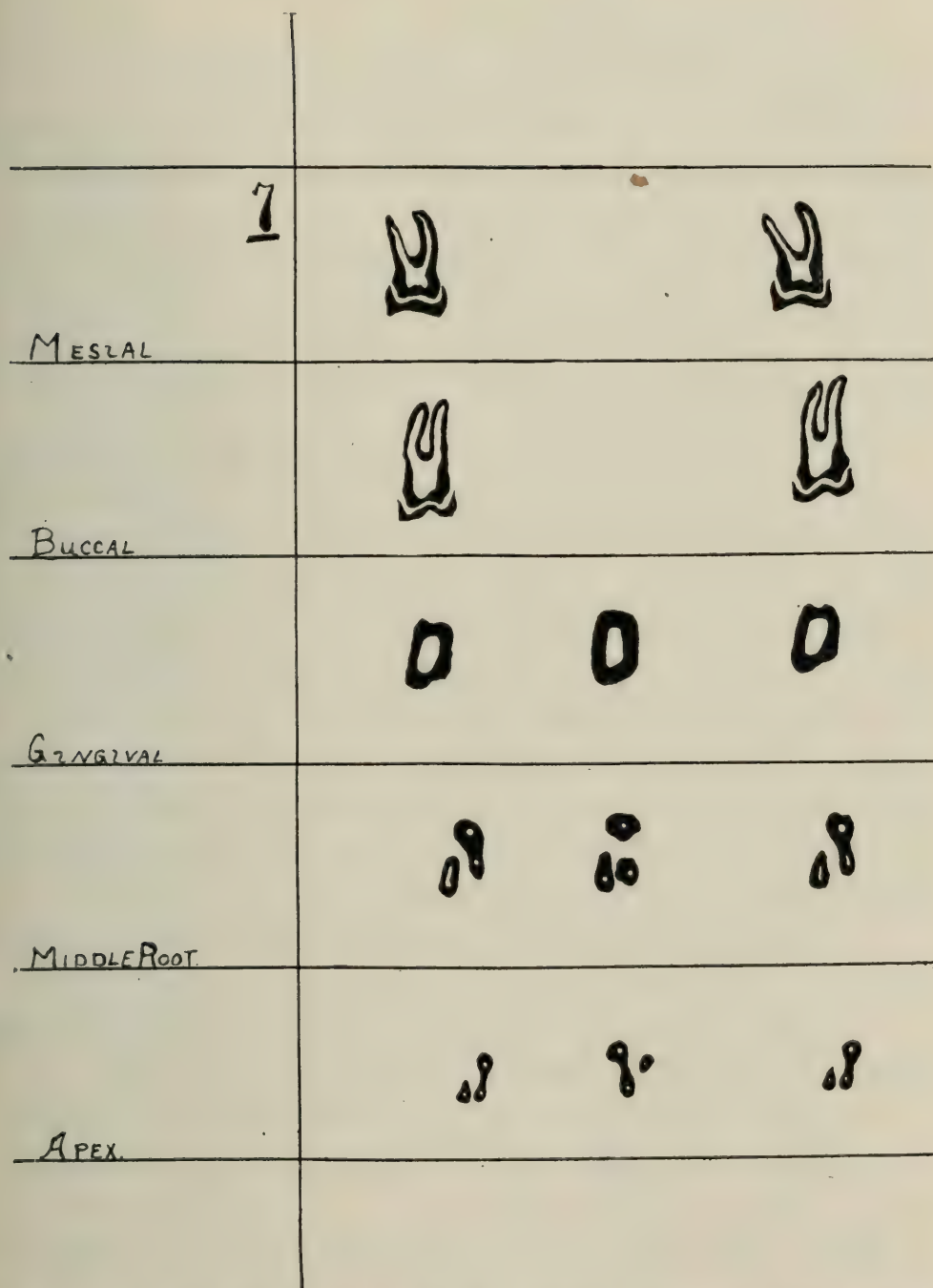


FIG. 49.—A page from a book of prints, showing longitudinal and transverse views of the pulp-chambers and canals of the upper second molar.

REVIEW QUIZ

1. Give the **definition** of a tooth, a human tooth, an unerupted tooth, and an impacted tooth.

A Tooth. A specialized organ, of a hard calcareous nature, usually located, though not always, in the mouth or some other part of the alimentary canal, designed for the purpose of assisting in the performance of one or more of the following acts or functions, viz.; prehension, incision, mastication, defense, attack, digestion, speech, and regulation of facial contour.

A Human Tooth. A specialized organ, of calco-globulinous nature, situated in the alveolar process of the upper and lower jaws, designed for purposes of mastication, to assist in articulate speech and to regulate facial contour.

An Unerupted Tooth (Human). A tooth in process of development, but which, although moving toward the surface is still unexposed to view.

An Impacted Tooth (Human). A tooth whose eruption is interfered with or prevented, with the result that it remains imbedded, and sometimes encapsulated, in the tissues of the structure in which it originated.

2. Define **angle** and distinguish between **line** and **point** angle.

3. Define **fossa** and give location and names of the **fossæ** on incisors and molars.

4. Define **lobe** and distinguish between **lobe** and **cusp**.

5. Define **ridge** and name the **marginal ridges** on incisors, cuspids, bicuspid and molars.

6. Describe the location of the **transverse ridge** on bicuspid.

7. Describe the location of the **oblique ridge** on molars.

8. Describe the location of the **triangular ridge** on bicuspid and molars.

9. On what teeth are **supplemental ridges** most frequently found?

10. Describe the location of the **developmental grooves** on incisors, cuspids, bicuspid and molars.

11. On what teeth are **supplemental grooves** most frequently found?

12. Name the **sulcate grooves** on cuspids, bicuspid and molars.

13. Define **groove, sulcus, fossa**.

14. Name the **roots** of upper bicuspid, upper molars and lower molars.

15. Name the **canals** in the same teeth.

16. Distinguish between **fossa** and **pit**.

17. Name the **pits** on bicuspid.

18. On what part of incisors are **pits** most frequently found?

19. Define **axial plane ; horizontal plane**.

20. Give another name for **cornua**.

21. Describe the **horns** of the pulp in incisors, cuspids, bicuspid and molars.

22. What conditions regulate the size of the cornuæ?

23. Give the **derivation** of the word "*incisor*."

24. Define the term "*succedaneous*" and name the **succedaneous teeth**.

25. Name the chief **points of difference** between the upper central and lateral incisors.

26. Name the chief **points of difference** between the upper and lower incisors.

27. Describe the **form** of the roots and root canals, on section, of the anterior teeth, upper and lower.

28. Describe the **form** of the roots and root canals, on section, of the upper and lower bicuspid.

29. Describe the **form** of the roots and root canals, on section, of the upper and lower molars.

30. Define the term "**cingule**" and give its most frequent location.

31. Define the term "**axial**."

32. Name the **surfaces** of all the teeth.

33. How are surfaces named?

34. Define **proximal surface**.

35. Define **median line**.

36. Distinguish between **line** and **plane of occlusion**.

37. Describe the difference in the **facial angle** of the Caucasian and Negro or mixed races.

38. Is the upper or lower **arch** the larger?

39. Describe the mesio-distal **occlusion of the teeth** beginning at the median line.

40. **With the teeth in occlusion**, describe the relation of the incisal edges of the upper and lower anteriors and the buccal and lingual cusps of the upper and lower bicuspid and molars.

41. Define **inclination** of the teeth.

42. Describe the inclination of all the teeth.

43. Describe the **interproximal space**.

44. Describe the **interproximal embrasure**.

45. What is the average **measurement of the arch** in inches?

46. Give the total measurement of all the **teeth at the necks**.

47. What is the average aggregate **measurement of the interproximal spaces**?

48. Under normal conditions, what tissues occupy the interproximal spaces?

49. Give the **formulæ** for the permanent and temporary teeth.

50. Write the **notation** for the following permanent teeth, viz: right upper central, left upper lateral, right lower cuspid, left lower first bicuspid, right upper second molar, left lower third molar.

51. What teeth are indicated by the following notations, viz.: $\underline{1}$, $\underline{2}$, $\overline{1}$, $\overline{3}$, $\overline{5}$, $\underline{6}$, $\overline{6}$?

52. Write the **notation** for all the temporary teeth.

53. Define **secondary dentin** and tell where and when it is found.

54. Describe the **pericementum** and give another name for it.

55. Define **rugæ**.

56. Define **gingiva** and give plural.

57. Define **frenum labium superioris**, **frenum labium inferioris** and **frenum linguæ**.

CHAPTER II

INSTRUMENTS AND APPLIANCES

The present chapter is devoted to a discussion of the various instruments used in operative dentistry. It is highly important that a thorough knowledge of the instruments and appliances, his armamentarium, be acquired by the reader, if the correct performance of the various operative procedures is to be accomplished.

He should be informed as to their nature, methods of manufacture, care and use, if he desires to do the best type of work. Good work cannot be accomplished with an inadequate equipment, or with dull instruments. Many cutting instruments, even when new, require sharpening before use, and all demand repeated sharpening at frequent intervals, in order that pain may be avoided and the work which they are intended to perform be expeditiously and easily accomplished.

All instruments should, after use, be properly cleansed and sterilized and then arranged in an orderly manner in the operating case. A definite place should be assigned each one, in order that it may be readily found when needed.

The following is intended only as a brief review of the working properties of steel. A fuller description may be found in works on metallurgy.

STEEL

Definition.—An alloy capable of being hardened, softened and tempered, made by the addition of a small percentage of

carbon to iron; melting point variously estimated at from 1500–1600° C.

Soft steel contains 0.5 per cent. or less of carbon. **Hard steel** contains from 0.5 per cent. to 1.5 per cent. of carbon.

Steel of an extreme degree of hardness, containing a large percentage of carbon, is utilized for making dental cutting instruments.

Hardening Steel.—Ordinary steel may be hardened to its limit by heating to a *full cherry red* color and immediately plunging in *cold* water. In this state it is extremely brittle. The more carbon it contains, the harder and more brittle it becomes.

Tempering Steel.—By tempering steel is meant the process of rendering it softer, tougher and less brittle. It is accomplished by heating to a *lower temperature* than that used for hardening steel, and then plunging in *cold salt water*, *slightly acidulated water*, *oil* or *mercury*. Oil gives a tougher temper than water, while mercury gives an extreme degree of toughness. Hard steel is capable of much more temper than soft steel.

Annealing Steel.—The operation of reducing it to its extreme degree of softness. This is accomplished by heating to *dull* or “*incipient*” *redness* and **cooling slowly**. A greater degree of softness is produced by covering with sand, plaster or pumice, thus excluding the atmosphere, heating and allowing to cool while so covered.

In the manufacture of dental instruments, hard steel (that containing a high percentage of carbon) of a higher or lower degree of temper is required, depending upon the purpose for which the instrument is intended. The following table shows the approximate temperatures, with the corresponding colors produced, to which instrument steel is carried in the making of various instruments:

Temperature	Color	Use
217° to 232°C.....	light yellow.....	enamel chisels, burnishers.
243°C.....	medium yellow.....	excavators, scalers.
258°C.....	brown-yellow.....	pluggers.
266°C.....	brown-purple.....	saws, shanks of instruments.
279° to 299°C.....	blue.....	spring temper.

Technical Exercises in the Working of Steel

1. **Making Smooth Broaches and Canal Explorers.**—Cut piano wire of the desired gauge to the required length and file to a point with a long taper; or utilize old, worn pulp canal cleansers for the same purpose by filing off the barbs and reducing to the desired size and taper. Remove file marks and polish with emery paper. These may be later used in the technic course as canal explorers and dressers. The points of those intended to be used for explorers and for placing cotton dressings in canals, where they are to be left temporarily, should be filed to a *sharp point*. Cotton, wrapped around a broach of this kind, has a natural tendency to come off. Those intended for swabbing and drying the canals, where it is desired to withdraw the cotton with the broach, should have their ends cut off *square*, with a pair of scissors, when it will be found that, when wrapped with cotton, they will retain it very readily.

2. **Making Hooked Extractors.**—Place the point of a piano wire broach (as made in No. 1) on an anvil. Lay the sharp blade of a knife $\frac{1}{8}$ inch from the end, with the edge of the blade pointing toward the shaft of the broach. Elevate the shaft of the broach, when the hook may be made at either a right, acute, or any desired angle, depending on the degree of elevation of the shaft. File the point to the desired length and sharpness. Polish as before.

3. **Exercises to Illustrate Annealing, Hardening and Tempering:**

(a) **Annealing.**—(1) Place a few smooth broaches on a plate of iron, heat to **“full cherry” redness** and allow to cool slowly. (2) Cover a few more with plaster, pumice or sand, heat to **“full cherry” redness** and allow to cool slowly. Note the difference in result accomplished by the two procedures. (3) Heat the small end of an excavator blank to **full cherry redness** and allow to cool slowly.

(b) **Hardening.**—Coat an excavator blank with soap to prevent overheating and burning out of carbon. Heat to **full cherry redness** and plunge in cold, slightly acidulated or salt water, oil or mercury.

(c) **Tempering.**—(1) Heat the shank and blade-end of the same excavator blank to **cherry red** and plunge immediately in any of the above media. Polish on the lathe to remove the oxides, which have accumulated on the surface. Test with a file to ascertain if full hardness has been produced. (2) If so, pass in the flame again and heat the blade-end to a **medium yellow color**; plunge immediately (thus tempering the blade-end), after which again polish to remove the oxides. (3) Place the small end in contact with a hammer to prevent drawing the temper at the point, apply the flame back of the shank and heat to a **blue color** (spring temper), immediately plunging in oil, thus tempering the shank.

INSTRUMENTOLOGY

Parts of an Instrument.—Instruments may be divided into those intended to be used by hand—**Hand Instruments**—and those for use in the dental engine—**Engine Instruments**. Most instruments consist of three parts, viz., (1) *Handle or Shaft*, (2) *Shank*, and (3) *Blade or Nib*. The *Handle or Shaft* is that part which is grasped by the hand in using (Fig. 51). The *Blade* is the cutting part of cutting instruments, while the

working part of pluggers is known as the *Nib*. The *Shank* is the part connecting the handle or shaft with the blade or nib. The taper from handle to blade is to impart proper balance to

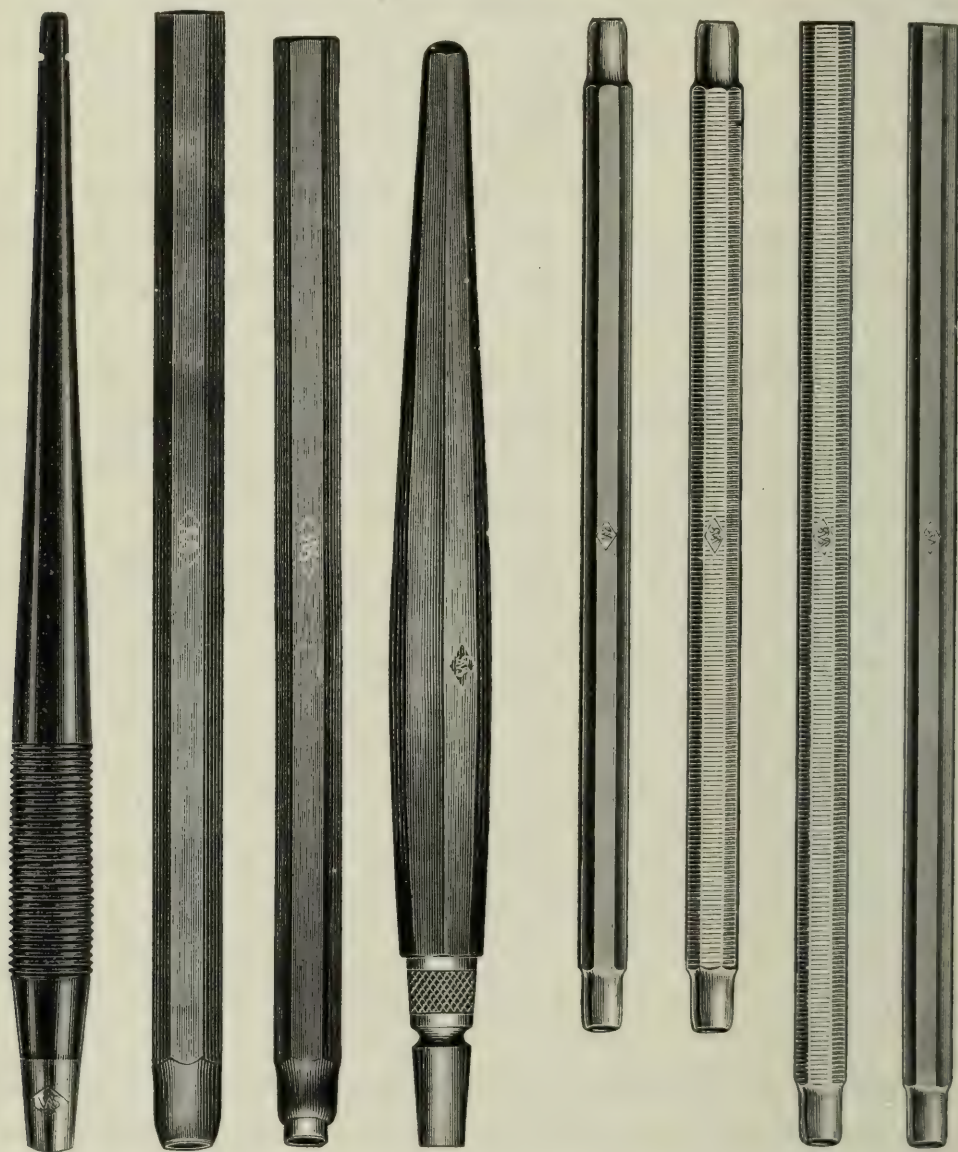


FIG. 50.—Vulcanite instrument handles. FIG. 51.—Steel cone-socket instrument handles.

the instrument and to give shape, lightness of touch and delicacy of manipulation. Most modern hand instruments in dentistry are intended for delicate manipulation and require

small handles, while some others are used for heavier work and should have larger handles. The rule in selecting handles is, the more delicate the work intended to be performed the smaller the handle and vice versa. Handles, whenever possible, should be of steel on account of convenience in sterilizing (Fig. 51).

Angles in Shanks.—The shank of an instrument may be straight or bent at various angles for better balancing of the instrument and to carry the blade or working part into inaccessible places. Dr. Black has classified instruments into (1) *Mon-angle*, (2) *Bin-angle*, (3) *Triple-angle*, and (4) *Quadrangle*, depending on whether they have one, two, three, or four angles in the shank.

Contra-angles.—For better balancing and in order to bring the blade as nearly as possible in a direct line with the long axis of the shaft, the shanks of instruments are also contra-angled. This form of instrument has a less tendency to turn in the hand when being used, and consequently will do better work with less strain on the operator. Contra-angle instruments are divided into (1) *Bin-angle Contra-angles*, (2) *Triple-angle Contra-angles*, and (3) *Quadrangle Contra-angles*, depending on whether there are two, three or four bends in the shank of the instrument. A well-balanced instrument should be so contra-angled as to bring its working point within 2 millimeters of the long axis of its shaft. For example of angles in instrument shanks see Fig. 60.

Instrument Grasps.—As soon as one begins to handle instruments, he should learn the proper grasps. Proper instrument grasps lead to proficiency in the performance of dental operations, and should be thoroughly studied and practised, if the best results are to be obtained. Carelessness in this respect will lead to bad habits which may cling throughout life. The three principal grasps are (1) *The Pen Grasp*,

(2) The *Inverted Pen Grasp*, and (3) The *Palm and Thumb Grasp*. There are other grasps which are occasionally used, but as they are of minor importance they will not be described.

(1) The **Pen Grasp** is most frequently used and is the one intended for great delicacy of touch. The instrument is held,



FIG. 52.—The pen grasp, the rest and the guard.

as the name indicates, like a pen in writing, except that the shank should be in direct contact with the pulps of the thumb and first and second fingers. With practice, this gives great power, facility, delicacy and range of movement. The second finger should not be allowed to crawl under the shank toward the finger-joint, as seen with some operators, thus limiting the range of movement and lessening the power of the thrust

(Fig. 52). A modification of the pen grasp is seen in Fig. 220, where the instrument is held between the balls of the thumb and first finger.

(2) The **Inverted Pen Grasp** is similar to the pen grasp except that the position of the instrument is reversed, so that the working part points toward, instead of away from, the hand. This grasp is only used occasionally. Fig. 219

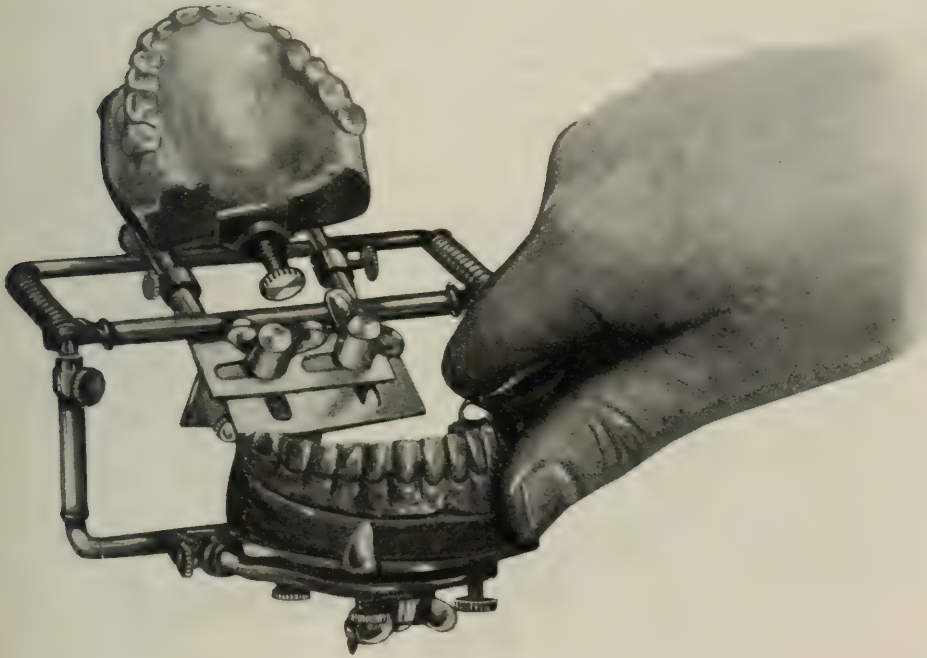


FIG. 53.—The palm and thumb grasp.

shows a modification of the inverted pen grasp. The position of the second finger is incorrect, as the instrument should lie against the pulp of the second finger.

(3) **The Palm and Thumb Grasp** is the grasp of power, and is accomplished by placing the instrument in a position similar to the one utilized in whittling a piece of wood, the handle, resting in the palm of the hand, being grasped by the four fingers, while the thumb rests on some adjoining surface (Fig. 53).

The strength of the thrust is largely influenced by the

proper use of the grasp and may be markedly increased by frequent exercise.

Rests and Guards.—While maintaining the proper instrument grasps, it becomes necessary to steady the *right hand* during the performance of the operation, in order that the instrument may be securely held to its work without slipping. In the case of the pen and inverted pen grasps this is accomplished by resting the fourth or fifth or both fingers on the tooth operated upon, or on some adjoining

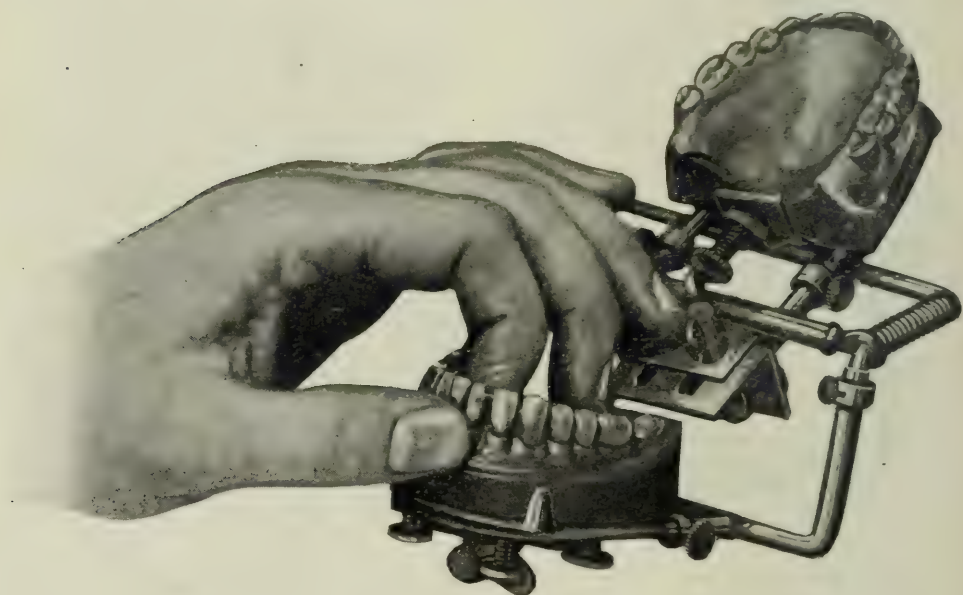


FIG. 54.—The guard.

tooth, or surface. The steadying of the hand is accomplished, when the palm and thumb grasp is assumed, by means of the thumb, resting it on some convenient location. This position of the fingers or the thumb is known as **The Rest** (Fig. 52). **The Guard** is the position assumed by the thumb and forefinger of the *left hand* to steady the parts operated upon and protect them from injury, in case of accidental slipping of the instrument (see Fig. 52). The thumb is placed on one side of the tooth operated upon and the forefinger on

the other, the position being reversed, depending on the location of the operation (Fig. 54). The practice of the proper rests and guards is important and should receive close attention in the technic laboratory at the same time that the study of instrument grasps is begun.

The Metric System of Measurement

Before taking up the study of instrument forms and their manufacture, it is necessary for one to have a knowledge of the metric system of linear measurement and the centigrade circle, together with their method of adaptation to the taking of the measurement of the various parts of instruments.

The metric or *French decimal* system is the one now adopted by most scientific men and the reader should begin at once to put its principles into use. It is based on the French meter, which equals 39.37 inches in the old measurement. The denominations of the system may be learned here, but the only method of thoroughly appreciating them is to put them into actual practice. These denominations, so far as their uses in dentistry require, are as follows:

One Meter.....	39 inches (approximate).
One Decimeter (one-tenth of a meter).....	4 inches (approximate).
One Centimeter (one-hundredth meter).....	$\frac{2}{5}$ inch (approximate).
One Millimeter (one-thousandth meter).....	$\frac{1}{25}$ inch (approximate).
Tenths, hundredths and thousandths of a millimeter.	
One thousandth of a millimeter is known as a micron and is used only in microscopic work.	

(Table from Black's Operative Dentistry.)

The Centigrade Circle.—This is a circle divided into one hundred parts or degrees, instead of 360° , as is the astronomical circle. To convert centigrades, the degrees represented in this circle, into astronomical degrees, multiply 360 by the number of centigrades and divide by 100; or (a simpler method)

after multiplying, cut off two figures (move the decimal point two figures to the left) as in calculating interest (Fig. 55).

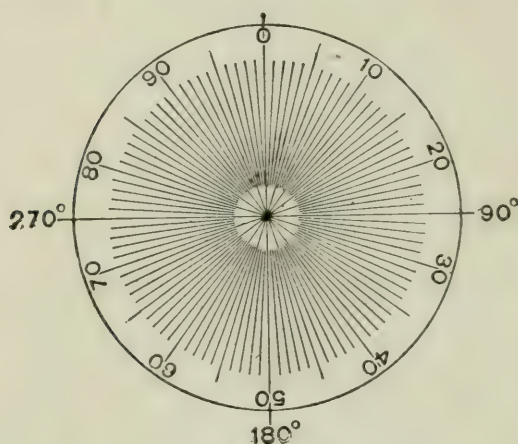


FIG. 55.—The centigrade circle. 25, 50 and 75 centigrades equal respectively 90, 180 and 270 astronomical degrees.

COMPARISON OF CENTIGRADE ANGLES WITH ASTRONOMICAL DEGREES (TABLE FROM BLACK)

6 centigrades.....	21.6 degrees
12 centigrades.....	43.2 degrees
18 centigrades.....	64.8 degrees
23 centigrades.....	82.8 degrees
28 centigrades.....	100.8 degrees
80 centigrades.....	288.0 degrees
95 centigrades.....	340.0 degrees

The Dental Instrument Gauge

The millimeter measure and the centigrade circle have been combined in an instrument known as the Dental Instrument Gauge. This appliance is largely used by instrument manufacturers for measuring the length, width and angle of the cutting edge of the blade and the angles in the shank of the instrument; but

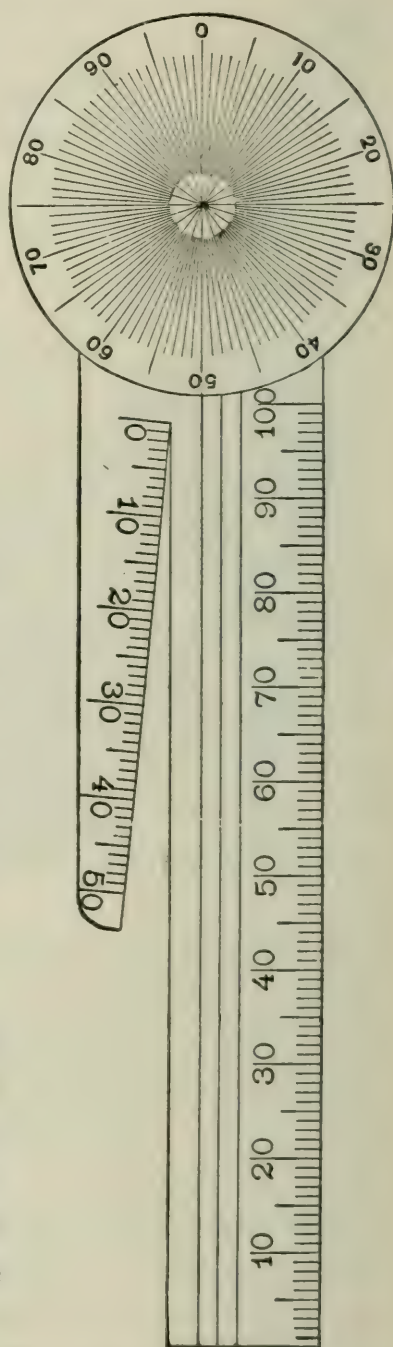


FIG. 56.—Dental instrument gauge.

its cost is almost prohibitive for general use of dental students. For measurement of angles in the technic work, in fact, for taking any measurements desired, good results may be accomplished on the illustration here given, if the instrument is not at hand (Fig. 56).

1. **To measure the width of the blade** lay it in the small slot numbered from 0 to 50, which will give the width in *tenths of a millimeter*.

2. **To measure the length of the blade** lay it lengthwise in the gradations on the principal bar and measure from the cutting edge to the first angle in the shank, which will give the length in *millimeters*.

3. **To measure the angle of the blade with its shaft** lay the handle or shaft on the main bar of the gauge and parallel with the lengthwise lines, having the blade turned toward the small numbers to the *right*; while holding it so, bring the length of the blade parallel with one of the gradations of the circle, which will give the angle in centigrades (Fig. 57).

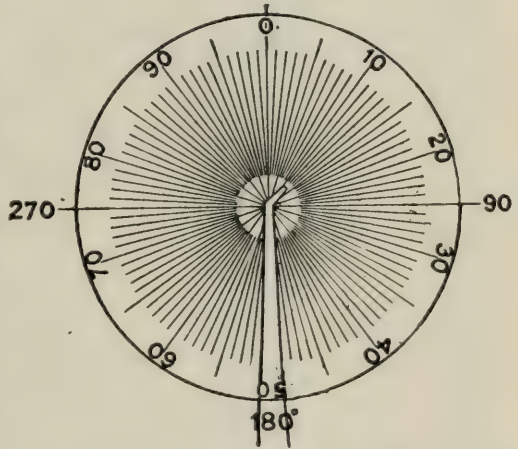


FIG. 57.—Measuring the angle of the blade with its shaft. (American Text-book of Operative Dentistry.)

4. **To measure the angle of the cutting edge of the blade with its shaft** lay the instrument in the same position as described in 3, and, without rotating it, move it to the left (keeping its shaft parallel with the lengthwise lines on the main bar of the gauge), until the angle of the blade is parallel with one of the gradations to the *left* of the circular head. This measurement is seldom necessary, as in most instruments the cutting edge is at right angles to the length of the blade.

Occasionally, though, variations are found, as in Black's Gingival Trimmers and in some varieties of chisel.

5. **To measure the amount of bevel of a blade** place the edge of the blade in the center of the circle, with one side of the blade on the zero division. The figure on the periphery of the circle on the line which follows the other side of the blade will give the amount of bevel in centigrades. The first two measurements here given are the only ones in the list of which the *Boley gauge is capable*.

Formula Names.—Dr. G. V. Black's set of instruments is designed largely after the first three methods of measurement given above, and the measurements are placed on the shafts of the instruments in the order given, the first measurement representing the width of the blade in tenths of a millimeter, the second representing its length in millimeters, and the third the angle of the blade with the shaft. In cases, however, where the fourth measurement, as described above, is necessary, it is placed second in the formula, the entire set of measurements being known as the *Formula Name* of the instrument (Fig. 58).

The Boley Millimeter Gauge

This instrument is sufficient for measuring all but the angles in the blade and shank of an instrument. The smaller gradations on the gauge are millimeters. The instrument is capable of measuring as much as 10 millimeters (1 centimeter) or as little as 0.1 millimeter ($\frac{1}{250}$ inch). For measuring in tenths of a millimeter a small scale known as **the Vernier**, located

FIG. 58.—Hatchet excavator showing formula on the handle. Figure 1 on the end of the handle is the catalogue number.



on the sliding piece by which the jaws of the instrument are opened, is used. On examination of the instrument, it will be seen that the divisions of this short scale (the Vernier) equal 9 divisions on the main scale. When the zero divisions on the main scale and the Vernier are together, the instrument is at rest and is not capable of registering a measurement. Now, move the *first* division on the Vernier in contact with the *first* division on the main scale and the instrument will register 0.1 millimeter; move the *second* divisions together and 0.2 millimeter are registered; the *third* divisions giving 0.3 millimeter, the *fourth* divisions giving 0.4, the *fifth* divisions giving 0.5, and thus continuing until 1 millimeter is registered. The Boley gauge is valuable for measuring instrument blades, plugger points, drills, burs, differences in the measurement of teeth of the same denomination in the mouth, in comparing measurements, in restoring angles of teeth in gold-building operations, in select-

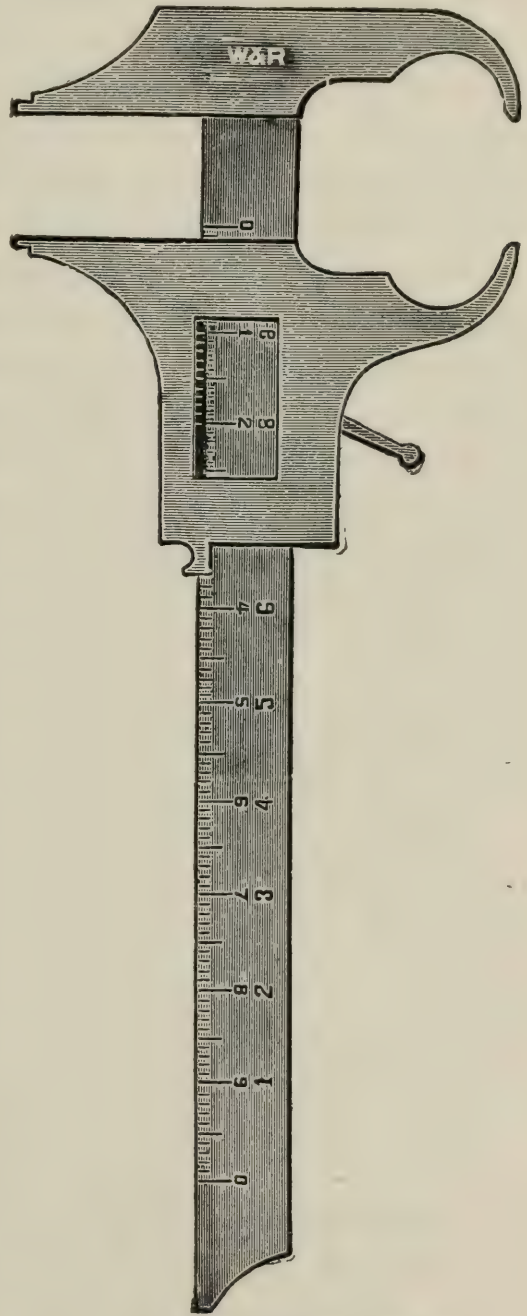


FIG. 59.—Boley millimeter gauge.

ing artificial teeth, and many other cases arising in dental practice. It should be in the hands of every dental student and practitioner (Fig. 59).

Instruments are known as **Long-handle Instruments** if the handle, shank and blade are all made from one piece of steel; if the shank and blade or nib are separate from the handle and intended to be screwed into it, the instrument is known as a **Cone-socket Instrument**. Examples of long handle instruments are shown in Fig. 73, while the Black set of pluggers seen in Fig. 85 are of the cone-socket variety. The *advantage* in the cone-socket instrument is that, if the working part is broken, it may be replaced at less expense; the *disadvantage* is its tendency to loosen at the joint. *Students should see that all cone-socket instruments are screwed tight into the handles before using.*

Bevels.—The blades of some cutting instruments, such as chisels, are beveled on only one side, while others, such as Hatchet Excavators, are **bi-beveled**, that is, beveled on both sides (see Figs. 60 and 61).

Rights and Lefts.—Instruments are frequently made in pairs, the angles in the shank throwing the working point of one to the right and of the other to the left, both instruments being intended to do the same character of work on opposite sides of a cavity or the mouth. These are known as **Rights and Lefts**. Familiar examples are spoon excavators and various hand-pluggers. See Fig. 60—Spoons 10, 6, 12 L; 10, 6, 12 R.

Names of Instruments.—The names of instruments are classified as follows:

1. *Order Names.*—These names denote the purpose for which the instrument is intended, as excavator, plugger, chisel, drill, mallet.

2. *Sub-order Names.*—These define the manner or posi-

tion of use of the instrument; as automatic mallet, hand plugger, pull scaler, bicuspid clamp.

3. *Class Names* describe the working point of the instrument; as hatchet excavator, spoon excavator, round bur, inverted cone bur, serrated plugger.

4. *Sub-class Names* indicate the shape of the shank; as Mon-angle, Bin-angle, Triple-angle, Contra-angle.

These names are frequently combined in the description of instruments, as Mon-angle Hatchet Excavator, Gingival Margin Trimmer, Triple-angle, Contra-angle Spoon Excavator.

CLASSIFICATION OF INSTRUMENTS

For purposes of description, instruments may be divided into (1) Cutting Instruments, (2) Condensing Instruments, (3) Miscellaneous Instruments. A brief description of each class follows:

1. **Cutting Instruments.**—Definition: Instruments for the cutting of the hard and soft tissues of the mouth, removal of deposits from the teeth, and for finishing fillings.

- | | |
|---------------|-----------|
| (a) Excavator | (h) File |
| (b) Chisel | (i) Saw |
| (c) Bur | (j) Knife |
| (d) Drill | (k) Wheel |
| (e) Reamer | (l) Point |
| (f) Lancet | (m) Disk |
| (g) Scaler | (n) Strip |

(a) **Excavator.**—An instrument for the excavation and removal of decay and the shaping of the internal parts of cavities. There are five forms, viz., the *hatchet*, the *hoe*, the *spoon*, the *discoid* and the *cleoid*. Their names indicate their form, they being designed after the ordinary hatchet, hoe, spoon, etc. (Fig. 60).

The *hatchet excavator* (Fig. 60; 12-5-12) has the edge of the blade running in a direction parallel with the handle, and is *bi-beveled*. In the *hoe excavator* (Fig. 60; 8-3-23) the edge of the blade is beveled on the side distal (away from) to the shaft and runs at right angles to it. The hatchet and hoe are used for the removal of the harder varieties of decay and to give form to the internal parts of cavities. The *spoons* (Fig. 60; 10-6-12) and *discoids* (round spoons) are intended especially for the scooping out of soft decay, and are beveled only

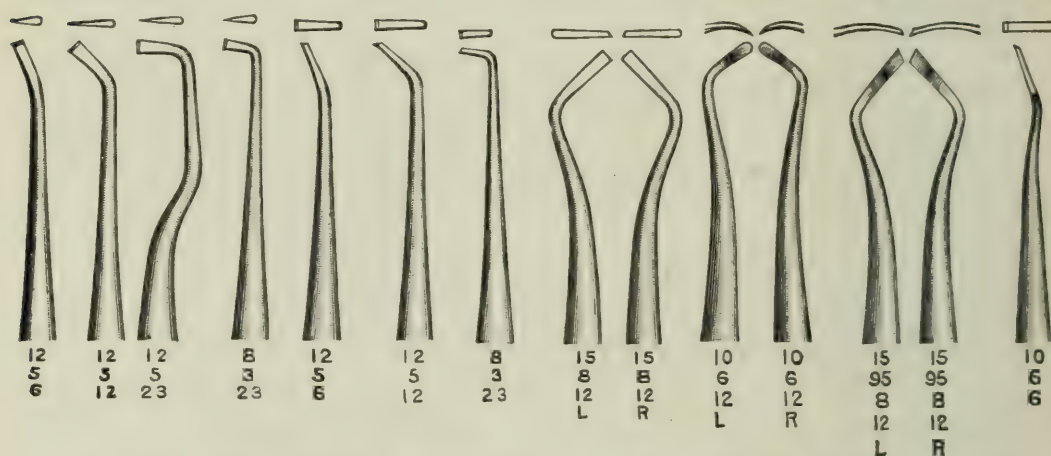


FIG. 60.—Black cutting instruments. Hatchet, hoe and spoon excavators enamel hatchets, gingival margin trimmers and a bin-angle chisel. Formula names are shown.

on the distal (far) side. *Cleoid* means claw-like, the instrument having a sharp point, with two rounded edges running from it—really a spoon excavator with the blade running to a sharp point. It is especially designed for deepening the angles of pulp chambers at the canal entrances.

(b) **Chisel.**—An instrument designed after the ordinary carpenter's tool, and intended for cutting enamel. It is beveled on only one side, and the shank may be straight or bin-angled (Fig. 61). *Enamel hatchet* is a variety of chisel in which the blade (bevelled on one side) is placed in hatchet form by contra-angling the shank (Fig. 60; 15-8-12). It is

made in rights and lefts with the bevel on opposite sides for cutting enamel.



FIG. 61.—Chisels.

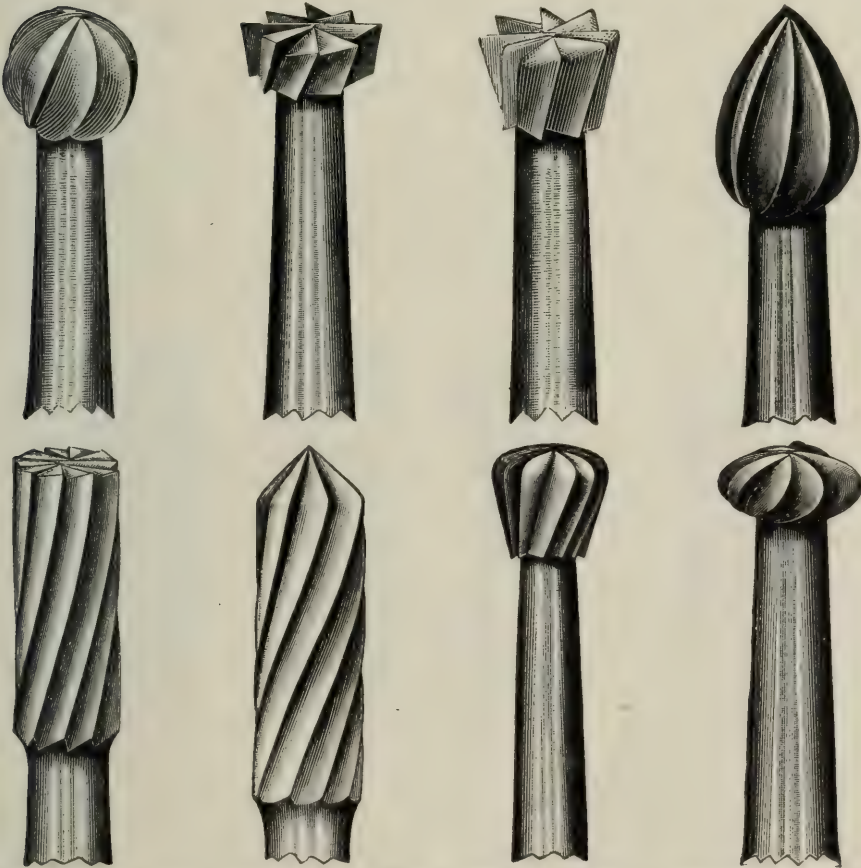


FIG. 62.—Engine burs (enlarged). The cone bur, being almost obsolete is not shown.

Gingival Margin Trimmer.—A variety of chisel especially designed for giving the proper bevel to gingival enamel mar-

gins; made in rights and lefts, two pairs of different size for beveling mesial cavities (cavities on the mesial surface) and two pairs for distal cavities (Fig. 60; 15-95-8-12).

(c) **Bur.**—A form of drill for revolution in the handpiece of the dental engine, intended for the rapid cutting of tooth structure during the removal of decay and preparation of cavities. Burs may be divided into two groups, according to shape and depending on whether intended to cut round or plane surfaces (Fig. 62).

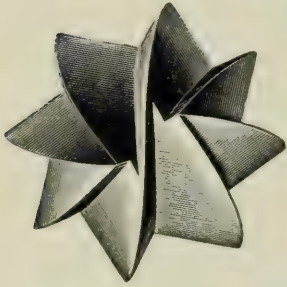


FIG. 63.—The round bur. Showing formation of the cutting blades.

Group 1 for cutting concave surfaces, includes the *round* (Fig. 63), *oval*, *pear*, *bud* and *pointed fissure burs*.

Group 2 for cutting plane surfaces and angles, includes the *cone*, *inverted cone*, *wheel* and *square or flat-end fissure burs*.

Dentate Burs are burs with the cutting blade divided into

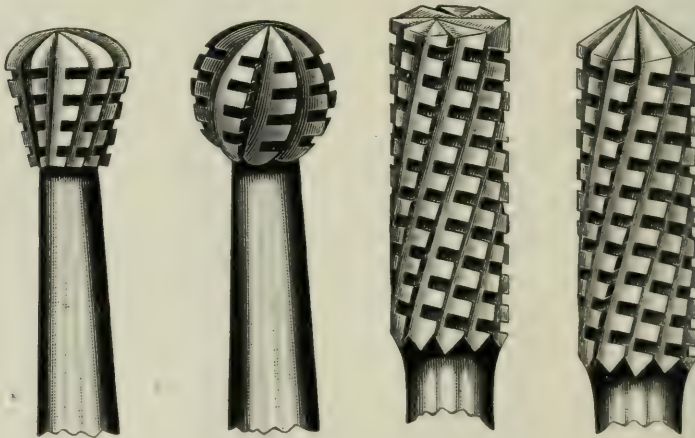


FIG. 64.—Enlarged dentate burs.

teeth, very rapid cutters, intended especially for attacking enamel (Fig. 64).

Plug-finishing Burs are burs of a finer cut of similar shape to those mentioned in Groups 1 and 2, intended for finishing and burnishing fillings.

(d) **Drill.**—An engine instrument used for boring or drilling holes in tooth structure (as in opening into a pulp chamber from the surface, where no cavity exists) or in bone (as during the treatment of an alveolar abscess). A drill is also valuable for following out fissures and for removal of old fillings. The *Spear-point* (Fig. 65), *Square* (Fig. 66) and *Twist* (Fig. 67) drills are familiar forms. A special form, known as a *Diamond* drill, is valuable for drilling cavities in artificial teeth. Drills may be readily made from old fissure and inverted cone burs by beveling them on opposite sides.

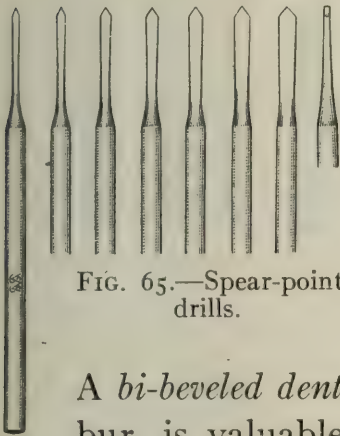


FIG. 65.—Spear-point drills.



FIG. 66.—Square drills.

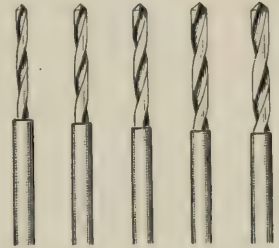


FIG. 67.—Twist drills.

A *bi-beveled dentate fissure bur*, made from an old dentate bur, is valuable for drilling through enamel and dentin.

(e) **Reamer.**—An engine instrument for enlarging root canals during treatment. Drills should never be used for this purpose, on account of the danger of perforation. A *flexible* reamer, which will follow the route of the canal and enlarge it, is usually indicated. Well-known varieties are the *Beutelrock* and *Gates-Glidden* reamers (Fig. 68). The *Peeso* and *Ottolengui* root reamers (non-flexible) are used for great enlargement during the placing of dowels. The *Kerr tapered canal reamers* (spiral form) (Fig. 69) are valuable for enlarging the entrance to canals.

(f) **Lancet.**—Synonyms, **Scalpel**, **Bistoury**. An instrument of knife form, designed for cutting the soft tissues.

Lancet is applied more frequently to that form of knife for use about the mouth, as in the lancing of abscesses and in all minor oral surgery operations (Fig. 70).



FIG. 68.—Gates-Glidden reamers.



FIG. 69.—Kerr tapered canal reamers.



FIG. 70.—Bistouries.



FIG. 71.—S. S. White scalers.

(g) **Scaler.**—An instrument for the removal of calculus. The blade is similar to the hoe and hatchet excavator. The instrument has various angles in the shank, and is used mostly

with a pull cut (Fig. 71). Scalers are made in rights and lefts, in many different sizes and shapes, some for the removal of large deposits on the crowns of teeth, and others for minute particles at the neck and under the gum (Fig. 72).

(h) **File**.—An instrument designed for filing down or removing surplus filling material. The *Black* (Fig. 73), *Searle* and “*Flexo*” files (Fig. 74) are prominent examples. *Rheine’s* and *D. D. Smith’s Approximal Trimmers*, popular varieties, are also useful.

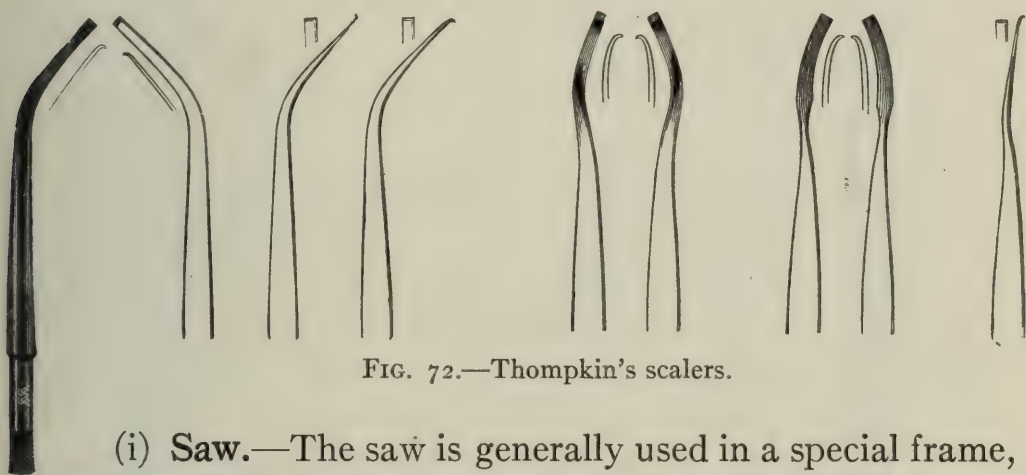


FIG. 72.—Thompkin's scalers.

(i) **Saw**.—The saw is generally used in a special frame, and has teeth on one or both sides. It is useful for separating teeth and for trimming surplus material from proximal fillings. The *Kaeber*, *Wilson*, *Clapp*, *Gordon-White* and “*thin-ribbon*” saws are prominent varieties (Fig. 75).

(j) **Knife**.—Synonym, *Trimmer*. An instrument with a thin, knife-like blade, made in various shapes, designed for trimming or shaving off surplus filling material at the gingival, buccal and lingual margins of proximal fillings. *Blacks’* (Fig. 76), *Wedelstaedt’s*, *Pichler’s* (Fig. 77) and *Gordon-White’s* are all useful examples.

(k), (l), (m), (n) **Wheel, Point, Disk, Strip**.—**Wheel**. A small grindstone ranging from $\frac{1}{2}$ inch to 1 inch in diameter, of various thicknesses and made of *corundum* or *carborundum*,

of which the latter is harder, cuts more rapidly and lasts longer (Fig. 78). **Point, Disk.** Made of the same materials

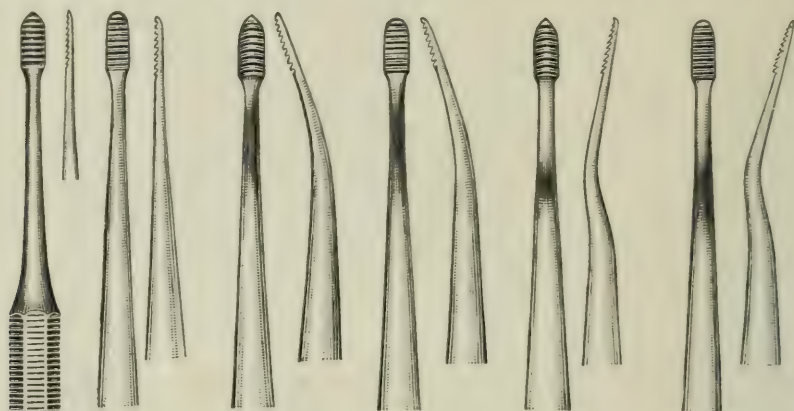


FIG. 73.—Black files.

and of *vulcarbo*, the **Point** (Fig. 79) being of various shapes, as barrel, cone, bud, bell, etc., and ranging in several sizes. Also made of Arkansas, Scotch and Hindoostan stone when intended for finer grinding, these materials being of a much smoother grain than carborundum. The "*Gem*" *Point* is excellent for finer grinding and for cavity margins. The *Diamond Point* and *Disk* are likewise valuable for cutting enamel, separating and finishing. The Diamond is largely utilized in this form for drilling cavities in artificial teeth. **Disks** (Fig. 81) are also made of paper and cloth, charged with emery, sand, garnet and cuttle-fish bone for polishing purposes (Fig. 81). The cuttle-fish disk is the finest grain of these, and is intended for very fine cutting and polishing. A variety of disk known as *Crocus* is very valuable for putting an extremely velvety finish to gold fillings. *Disks* for carrying polishing powders, such as pumice, corundum flour, chalk, oxide of

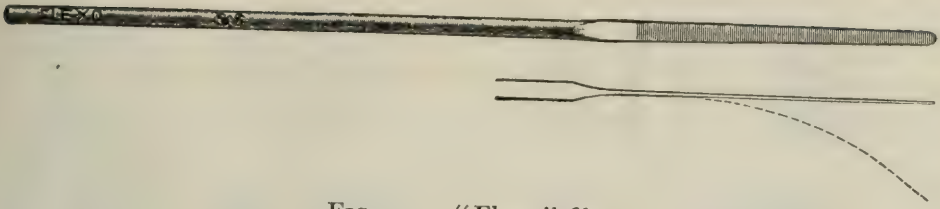


FIG. 74.—“Flexo” file.



FIG. 75.—Kaeber saw-frame and saw.

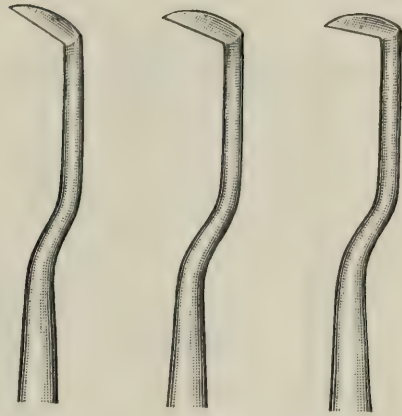


FIG. 76.—Black knives.

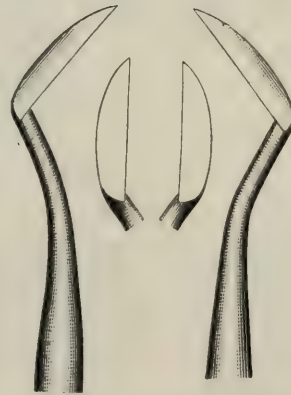


FIG. 77.—Pichler knives right and left.

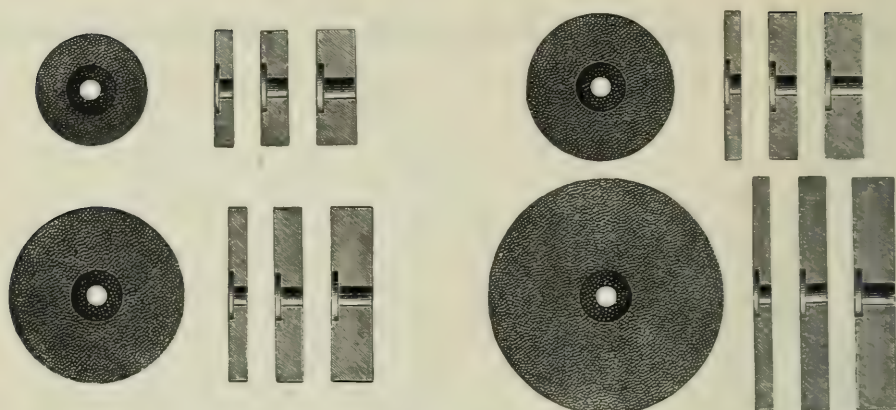


FIG. 78.—Carborundum wheels.



FIG. 79.—Carborundum points.

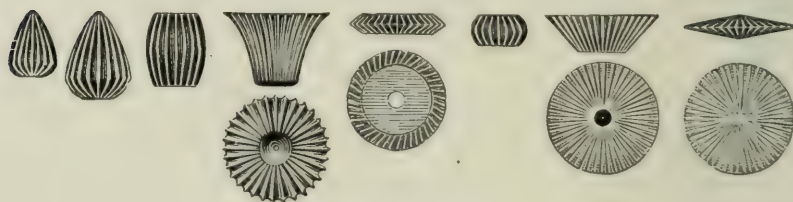


FIG. 80.—Soft rubber polishing points.

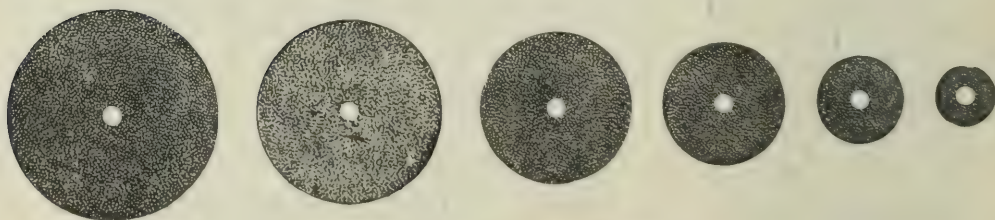


FIG. 81.—Emery cloth disks.

tin, whiting and rouge are made of celluloid, felt, leather, moose hide, soft rubber, chamois, etc.; while *points* for the same purpose are made of wood, leather, felt, chamois and

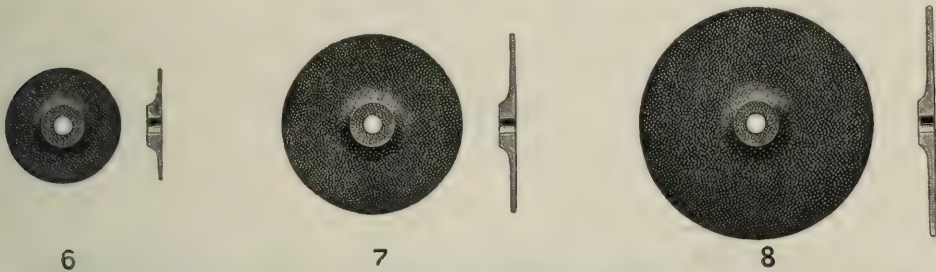


FIG. 82.—Carborundum disks.

soft rubber (Fig. 80). Special *mandrels* are made for mounting all of the above (Fig. 83). Cloth and paper STRIPS of various widths and charged with the same materials as the disks, as well as with carborundum, flint and lava, are utilized for finishing and polishing fillings. *Celluloid strips* are valuable for finishing silicate fillings and for use as matrices.

Sharpening Cutting Instruments.

The workman is known by his tools. A glance into the operating case of a student or a dentist is sufficient to enable a good judge to gauge the capabilities and character of work being done by its owner.

Cutting instruments should be kept sharpened if ideal results are desired. The possession of a good Arkansas stone (Fig. 84) is essential to the attainment of this object. The stone should be slightly moistened with a drop or two of lubricating oil. Avoid too much oil. The passage of an excavator or chisel over the stone with a few long, firm strokes will be sufficient, if resorted to at regular intervals, to keep the



FIG. 83.—Disk mandrel.

instrument sharp. Care should be taken to follow the original bevel of the blade and not to establish false bevels during the sharpening process.

The stone should rest on a firm surface, should be kept clean and free from grit and scratches. Some dentists prefer to hold the instrument to be sharpened in the left hand while manipulating the stone backward and forward with the right.

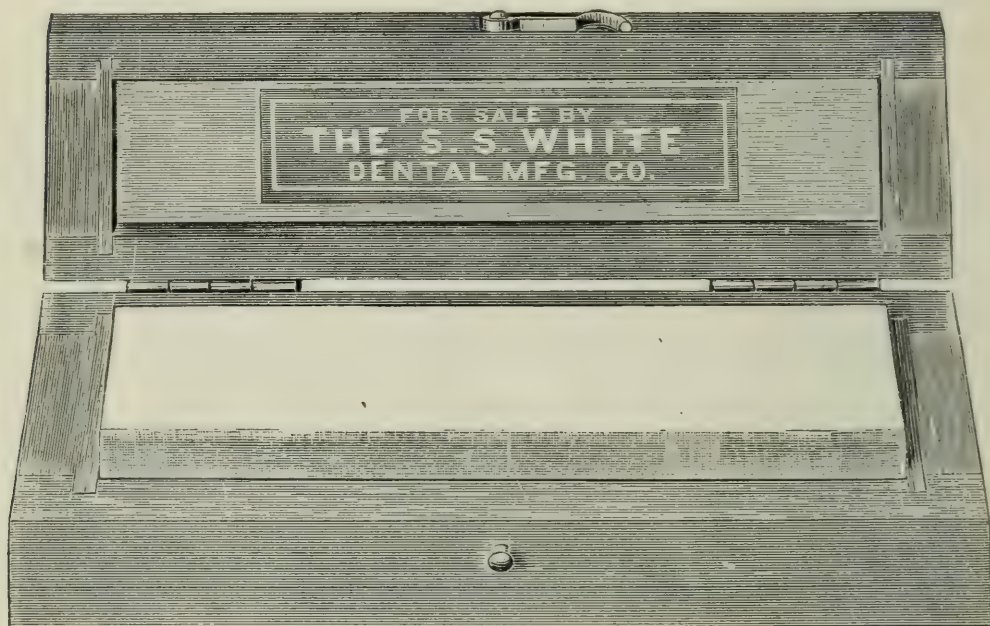


FIG. 84.—Arkansas stone in case.

2. **Condensing Instruments.**—*Definition:* Instruments designed for packing, plugging or condensing, mixing and smoothing filling materials.

(a) Plugger

(c) Spatula

(b) Burnisher

(d) Mallet

(a) **Plugger.**—An instrument designed for plugging, packing or condensing filling materials. (1) Gold and (2) Amalgam Pluggers. (1) *Gold Plugger* (Fig. 85). For plugging

or building gold, a plugger with a small face or *nib* should be used (0.5 mm. to 1 mm. in size), while for the final condensa-

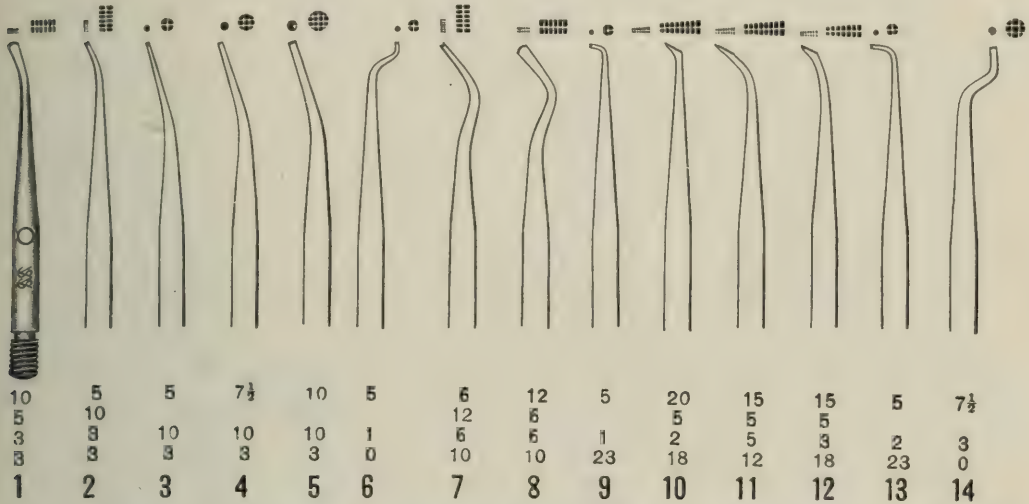


FIG. 85.—G. V. Black set of cone-socket plugger points. Formula names are given.

tion of the filling a larger size (foot plugger) should be utilized. The gold plugger is made for hand pressure, handmallet or some form of mechanical mallet (Fig. 86). The working

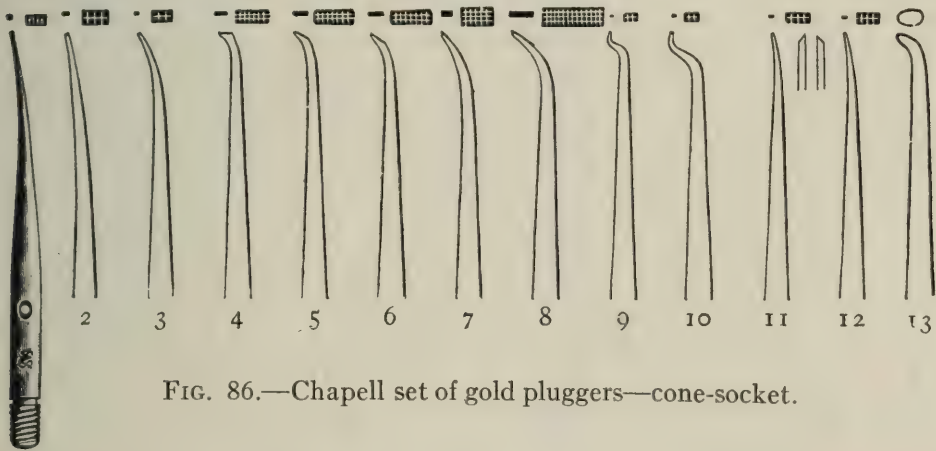


FIG. 86.—Chapell set of gold pluggers—cone-socket.

point or nib is serrated (Fig. 87) and in most instances presents a plane surface, though some are rounded or convex, while some are concave (Fig. 88). The outline form is either

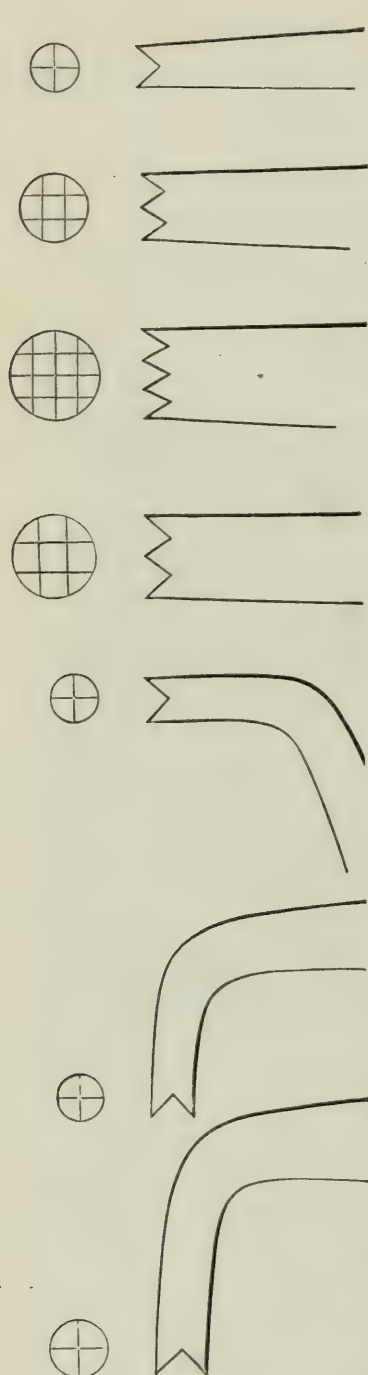


FIG. 87.—Diagrammatic illustration showing serrations in the nibs of the round instruments in the Black set of pluggers.

round, oval, square, oblong or parallelogram, triangular, or foot-shaped (Fig. 89). (2) *Amalgam Plugger*. For packing and condensing amalgam a larger size plugger is indicated, the selection depending on the size and shape of the cavity (Fig. 90). The amalgam plugger should be serrated to obtain the best results, though many with smooth faces (burnishers) are manufactured. Amalgam pluggers, as well as gold pluggers, are made in cone socket or long handle, with all forms of angle in the shank (Fig. 91).

(b) **Burnisher**.—An instrument designed for burnishing and smoothing the surface of a filling and for inserting cement, gutta-percha and amalgam into cavities (Figs. 92, 93, and 94). Burnishers are made of steel, agate, blood-stone, ivory, stellite and tantalum. For burnishing the surfaces of fillings, steel is the best material, while for working cements, instruments made of some of the other materials may be utilized. The silicate cements do not allow of contact with steel, so that the agate, tantalum, ivory and stellite instruments are used in their manipulation. Burnishers are primarily hand instruments, but they are also made to be used in the engine hand piece for burnish-

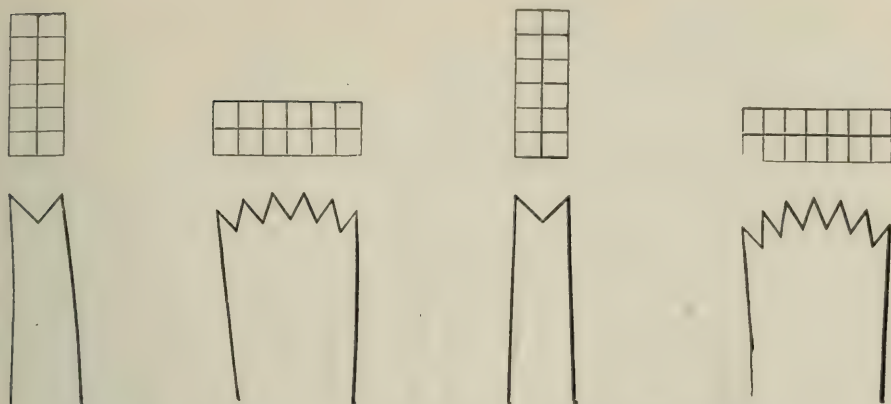


FIG. 88.—Serrated nibs, parallelogram form. Black pluggers.

ing the surface of fillings, when they are known as **engine burnishers**.

(c) **Spatula**.—An instrument with a flat, unsharpened blade, made in various sizes, for mixing cement and for introducing and smoothing the surface of cement fillings. A spatula is made of steel, stellite, bone, tantalum or other material (Fig. 95).

(d) **Mallet**.—Hand and Mechanical. The **hand mallet** is made of wood, lead, steel and other materials, in various sizes and weights. It is utilized for malleting gold and amalgam fillings, driving wedges in separating teeth and in delivering blows for other purposes, as in chiselling enamel. The **mechanical mallet**, designed for plugging gold, is of four varieties, viz.:

(1) The *Automatic* (the most popular), in which the blow is delivered to the plugger by the releasing of an actuating spring concealed in its shaft (Fig. 96):

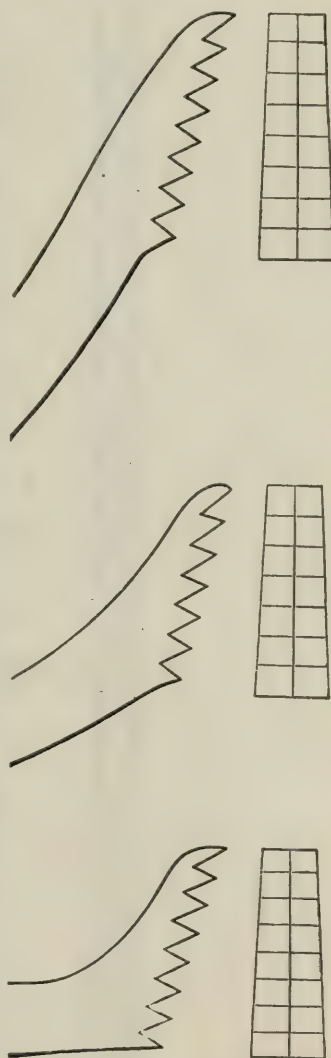


FIG. 89.—Foot pluggers. Black set.

(2) The *Engine or Mechanical* (used on the dental engine), its action depending on the rapid revolution of a disk with a

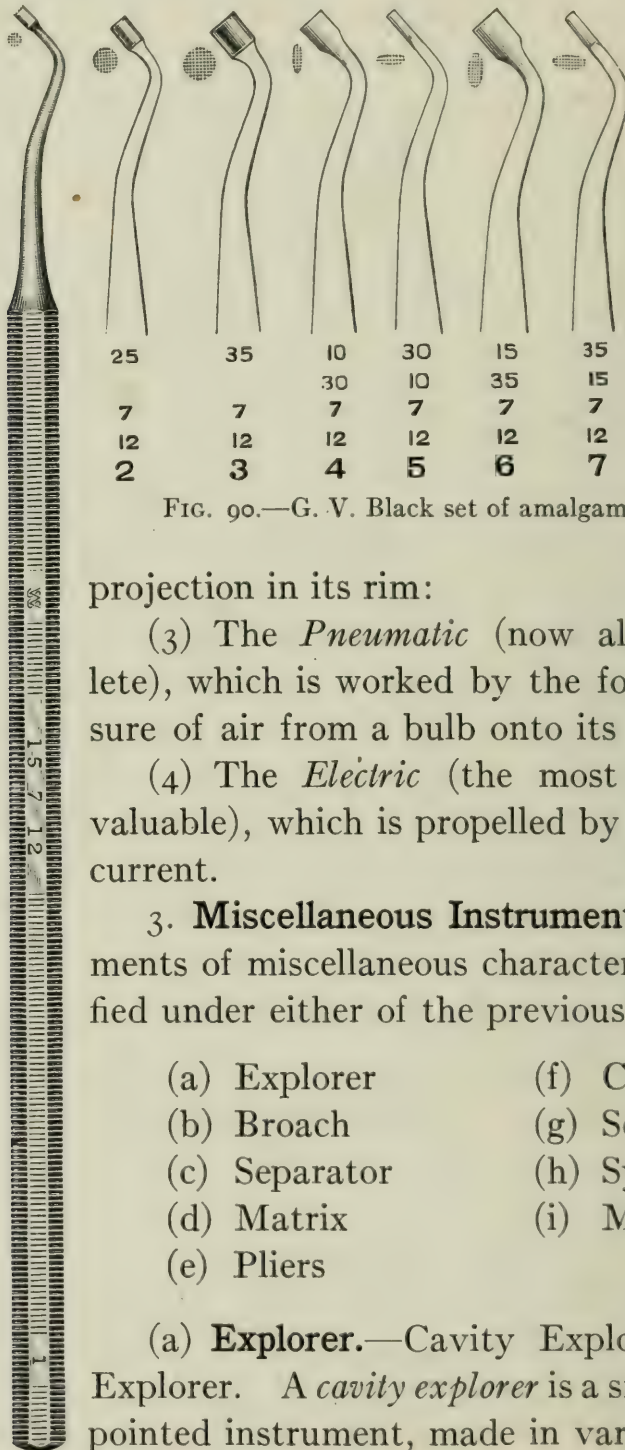


FIG. 90.—G. V. Black set of amalgam pluggers.

projection in its rim:

(3) The *Pneumatic* (now almost obsolete), which is worked by the forcible pressure of air from a bulb onto its piston; and

(4) The *Electric* (the most rapid and valuable), which is propelled by the electric current.

3. **Miscellaneous Instruments.**—Instruments of miscellaneous character not classified under either of the previous headings:

- | | |
|---------------|--------------|
| (a) Explorer | (f) Clamp |
| (b) Broach | (g) Scissors |
| (c) Separator | (h) Syringe |
| (d) Matrix | (i) Mandrel |
| (e) Pliers | |

(a) **Explorer.**—Cavity Explorer—Canal Explorer. A *cavity explorer* is a small, sharp-pointed instrument, made in various shapes



FIG. 91.—Loaded amalgam carrier and plugger.



FIG. 92.—Burnisher.

for searching out cavities of decay (Fig. 97). A *canal explorer*, or *smooth broach*, is a small, delicate instrument, with

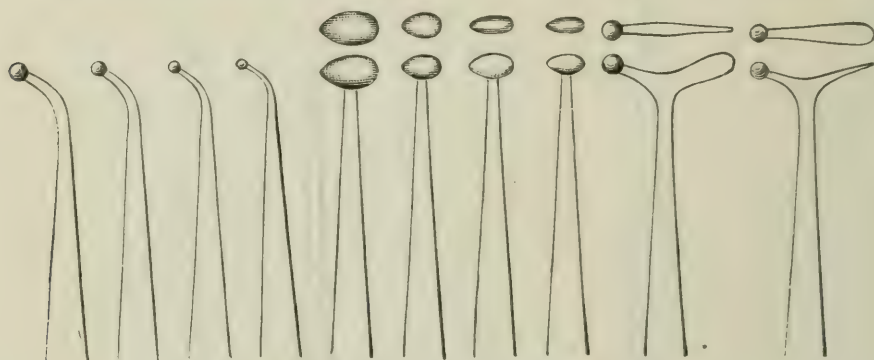


FIG. 93.—Burnishers.

a long taper and sharp point, made in various sizes for following the intricacies of canals.

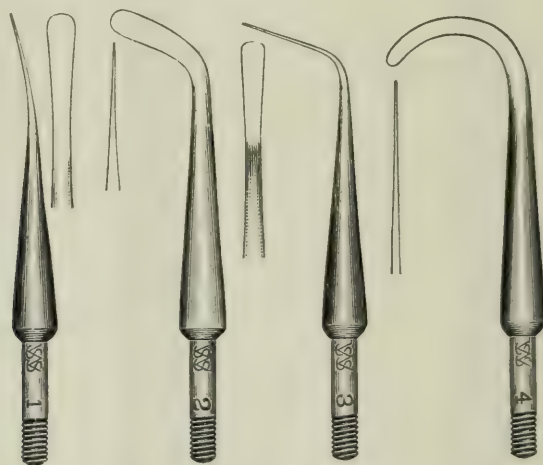


FIG. 94.—Thin burnishers.

(b) **Broach.**—An instrument designed for the exploration, measurement of the length and dimension, removal of the contents, enlargement and filling of root canals.

- (1) Smooth broach
- (2) Hooked broach
- (3) Barbed broach
- (4) Twist broach



FIG. 95.—Cement spatula.



FIG. 96.—Auto-
matic plugger.



FIG. 97.—Double end cavity ex-
plorers. Rights and lefts. Num-
bers 2 and 3 are contra-angles.

(1) A *smooth broach*, in addition to the uses already given, is also utilized for placing dressings in and drying out canals. One variety is *round*, another is *square* (also known as a Swiss or Jeweler's broach or reamer) and others are three or five



FIG. 98.—Enlarged barbed broach.

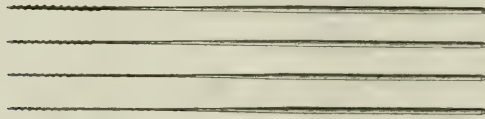


FIG. 99.—S. S. White canal cleaners. (Barbed broaches.)

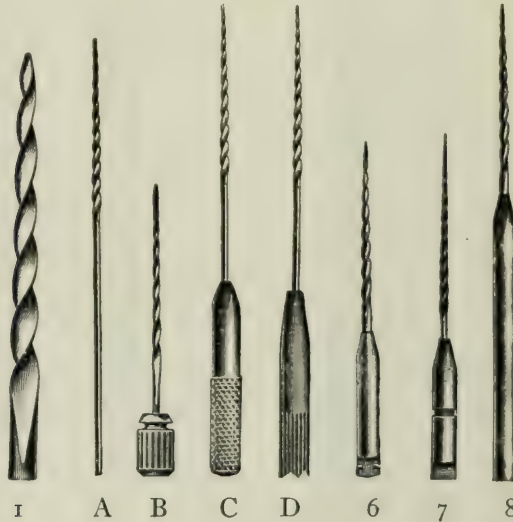


FIG. 100.—Kerr twist or spiral broaches. No. 1 is enlarged. B is a nub-broach. Nos. 6, 7, 8, are for the engine hand-piece.



FIG. 101.—Metal broach-holder.

sided. The smooth broach may be obtained annealed or un-annealed, the un-annealed variety being extremely brittle and easily broken. For canal work the temper should usually be drawn, as already described. (2) *Hooked broach*—hooked

extractor—a smooth broach with a hook on the end, either at a right or acute angle, used for removing pulps and for measuring the length of canals. (3) *Barbed broach*—canal cleanser—a broach with small barbs or teeth, used for removing pulps and for *rasping* the sides of canals during cleansing and enlarging operations (Fig. 99). It is made in extra fine, fine, medium, or large sizes and may be obtained in packages of six assorted, or in the separate sizes. Prominent forms are the *Donaldson*, the *S. S. White* (Fig. 99) and the

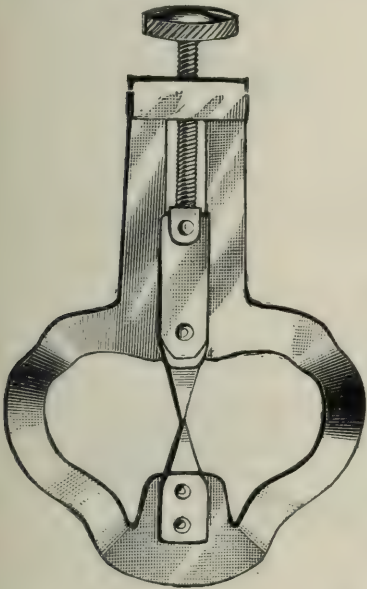


FIG. 102.—Ivory universal double-bow separator.

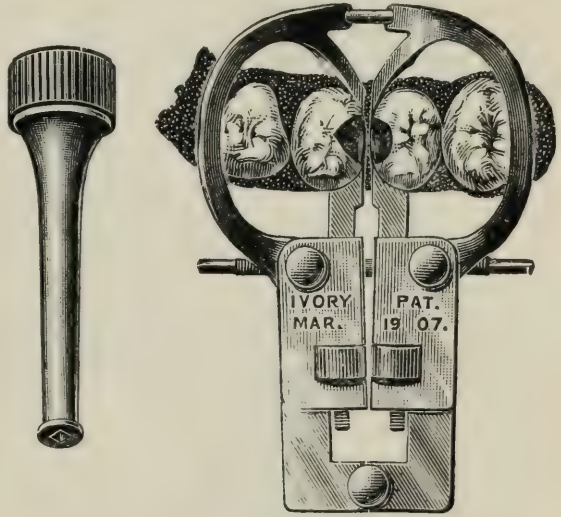


FIG. 103.—Ivory separator. New form.

Fellowship broaches. (4) *Twist broach*. A tapered spiral broach, designed and operated on the principle of an auger, for enlarging or reaming canals (Fig. 100). It is made in extra fine, fine, medium, coarse and extra coarse sizes, and is a much safer instrument than the engine reamer. It, as well as the other varieties of broach, is designed to be used either in a *broach handle* (broach holder) (Fig. 101) or as a long-handle instrument. There is also a variety of twist broach known as a **Nub broach** (see illustration, Fig. 100) intended for

operations on the lower teeth. Of these the *Downie* and *Kerr* are the most prominent makes.

(c) **Separator.**—A steel instrument, designed for forcing apart (wedge separator) or drawing apart (traction separator) two approximating teeth, thus gaining space for making examination of, or operating in, inter-proximal spaces. The *wedge separator* acts on the principle of a wedge, by the forcing together of two steel points; the *traction separator* acts in the opposite manner by the drawing apart of two pairs of points; while some instruments combine both principles. The *Ivory*

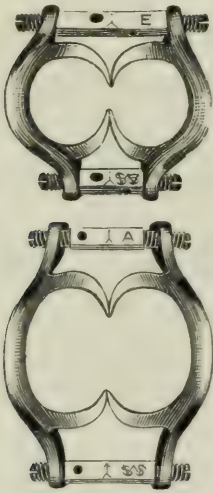


FIG. 104.—Perry separators.

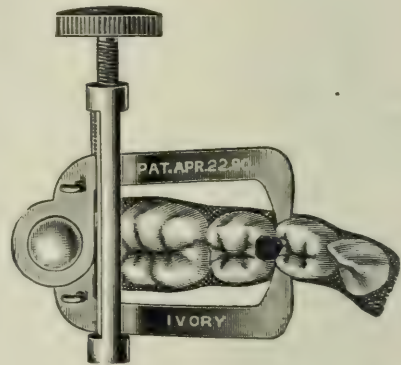


FIG. 105.—Elliot separator.

(Figs. 102 and 103), “*Perry*” (Fig. 104), “*Little Giant*” and *Elliot* (Fig. 105) separators are prominent examples.

Separation of the teeth is also accomplished through the expansive properties of such materials as wood, cotton, linen tape and gutta-percha (slow or previous separation).

(d) **Matrix.**—A thin band or strip of steel, German silver or copper about 0.001 inch in thickness, used to restore the fourth or missing wall in filling proximo-occlusal cavities, thus converting them into simple cavities. The simplest form of matrix is a thin strip of metal held in position by means

of a wooden wedge. The patent varieties of matrix are numerous, consisting of the *matrix band* and its *retainer*, and range from those occupying one inter-proximal space to those

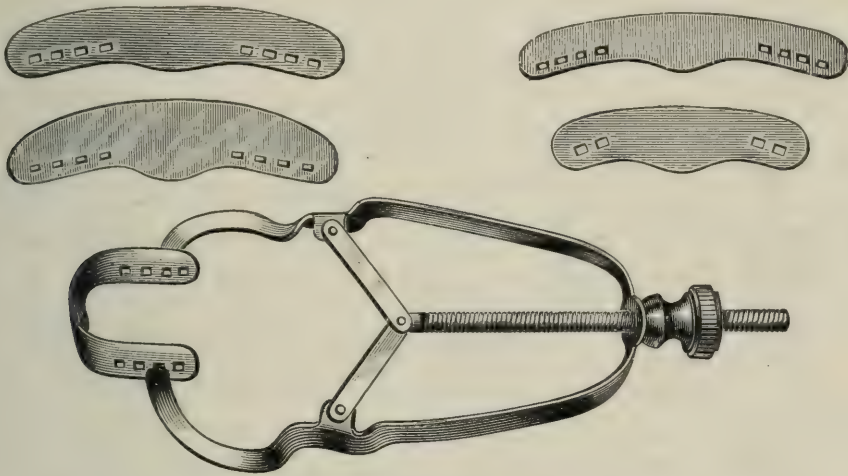


FIG. 106.—Ivory matrix retainer No. 1 and matrix bands.

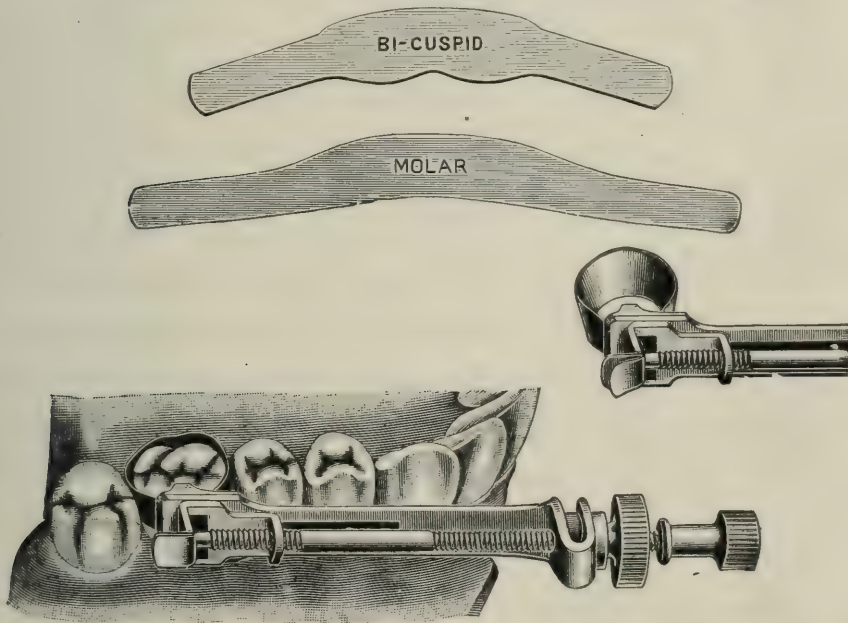


FIG. 107.—Ivory matrix retainer No. 8 with bands.

partially or completely encircling one or two teeth. In some, provision is made for immediate separation of the teeth during their application. The *Ivory*, *Brophy*, *Woodward* and *Crenshaw* are prominent forms (Figs. 106 and 107).

(e) **Pliers.**—"A kind of pinchers by which any small object may be seized and bent"—Webster's Unabridged Dictionary.

Dressing Pliers are utilized for carrying cotton for purposes of swabbing, drying or medicating cavities and pulp chambers. Another variety of pliers, known as a *foil carrier*, is used for handling gold, the beaks of some of these being serrated, when they are known as *plugging pliers*. *Cone-socket pliers* are used for tightening cone-socket instruments in the handle.

(f) **Clamp.**—"Something that fastens or binds"—Webster's. A *rubber dam clamp* is a small steel appliance to clamp the neck of the tooth and hold the rubber dam in position (Figs. 108 and 109). An infinite variety of forms and sizes have been designed for every conceivable shape of tooth, although the bicuspid and molar clamps are most used. They are carried into position by means of *rubber dam clamp forceps* (Fig. 110). The "Ivory" and "S. S. White" line of clamps are the most prominent varieties. A form known as the *cervical clamp* is utilized in cases where it is necessary to force the

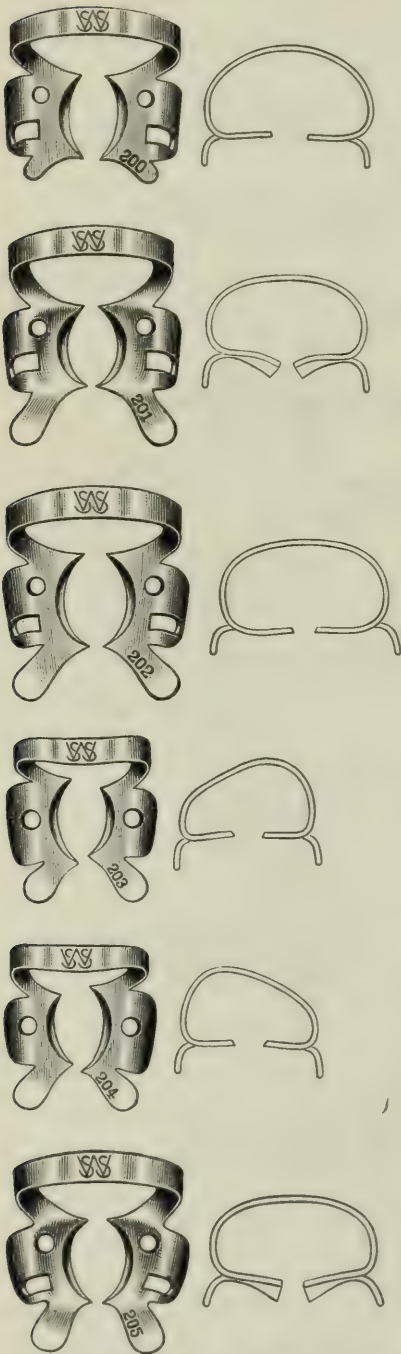


FIG. 108.—S. S. White rubber dam clamps for molars. The ivory clamps are practically of the same form.

dam well up beyond the margin of cervical cavities. Of these the *Ivory* (Fig. 111), *Dunn, Johnson* (Fig. 112), *Keefe* and *How* (Fig. 113) may be mentioned. *Matrix Clamp* is another name for Matrix Retainer. A *Cotton Roll Clamp* is a clamp designed to hold napkins or cotton rolls in position in the mouth for excluding moisture.

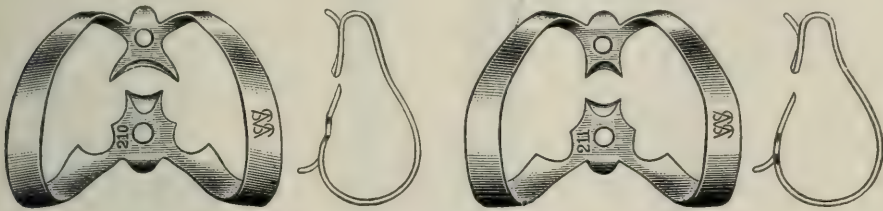


FIG. 109.—Rubber dam clamps for anterior teeth.

Adjuncts and Accessories

- (a) Ligature
- (b) Rubber Dam
- (c) Absorbent
- (d) Mirror
- (e) Scissors
- (f) Syringe

(a) **Ligature.**—Waxed floss silk is the most popular material for ligating the rubber dam in position. Hemp thread or gilling twine and small sea-grass fish line are also used for this purpose, as well as for regulating teeth, on account of their additional strength. Brass and copper wire are likewise valuable for this purpose in special cases.

(b) **Rubber Dam** (c) **Absorbent.**—In operating in the mouth, *dryness* is essential. For *short* operations, the teeth to be operated upon may be excluded from moisture by the use of small folded napkins, or cotton rolls (absorbents) of various sizes. For *long* operations small holes are punched in rubber cloth (rubber dam) and this is ligated in position,

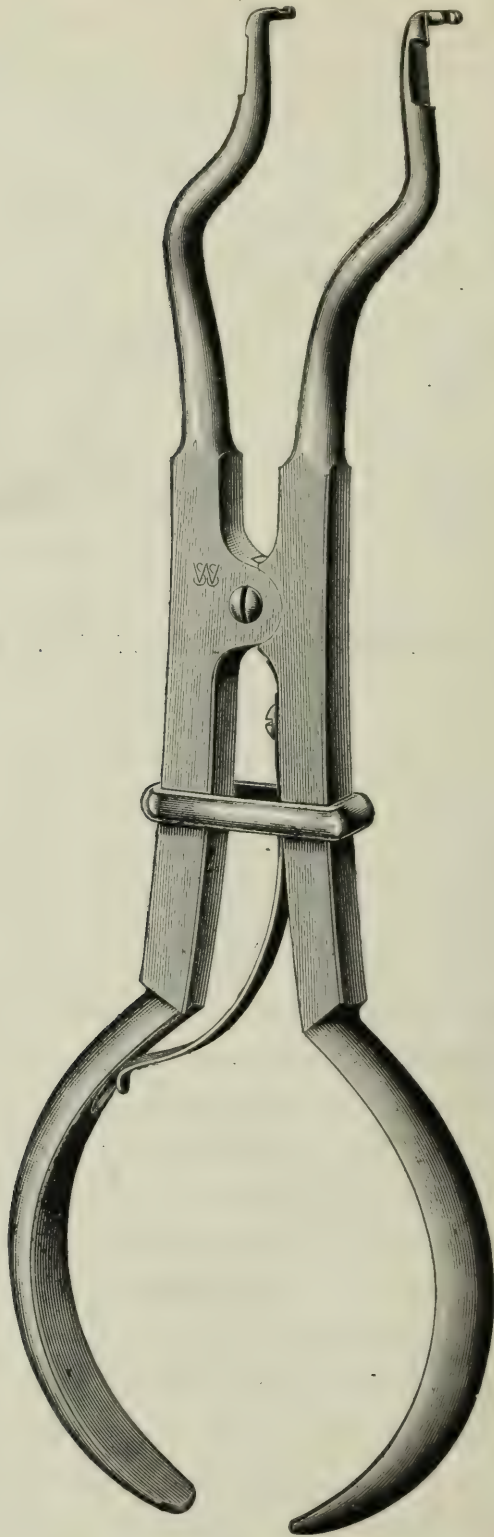


FIG. 110.—Rubber dam clamp forceps.

or held, by means of rubber dam clamps (Figs. 114 and 115). For drying the surfaces of teeth, cavities, pulp cham-

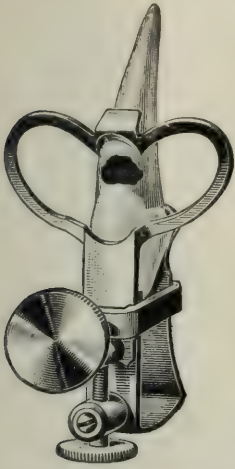


FIG. 111.—Ivory cervical clamp.

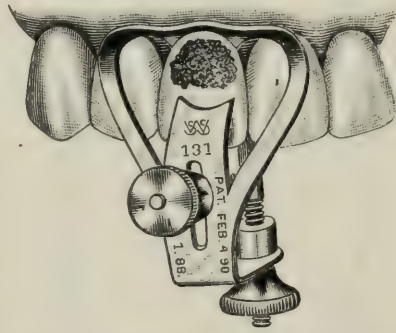


FIG. 112.—Johnson cervical clamp.

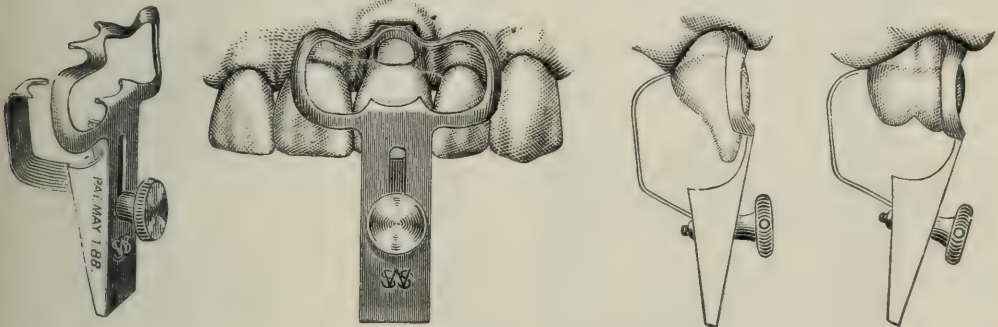


FIG. 113.—How cervical clamp.

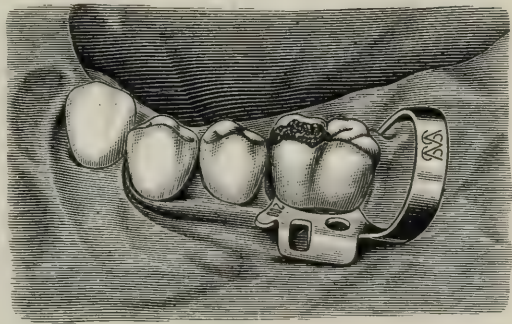
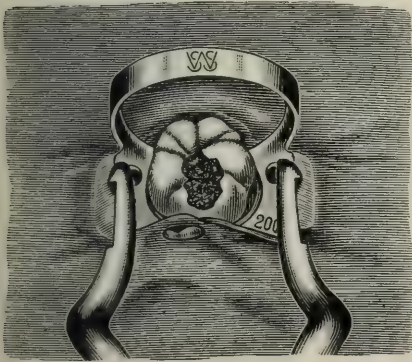


FIG. 114.—Adjusting the rubber dam. FIG. 115.—The rubber dam adjusted.

bers and canals, cotton, cottonoid, spunk and bibulous paper (absorbents) are the principal agents used.

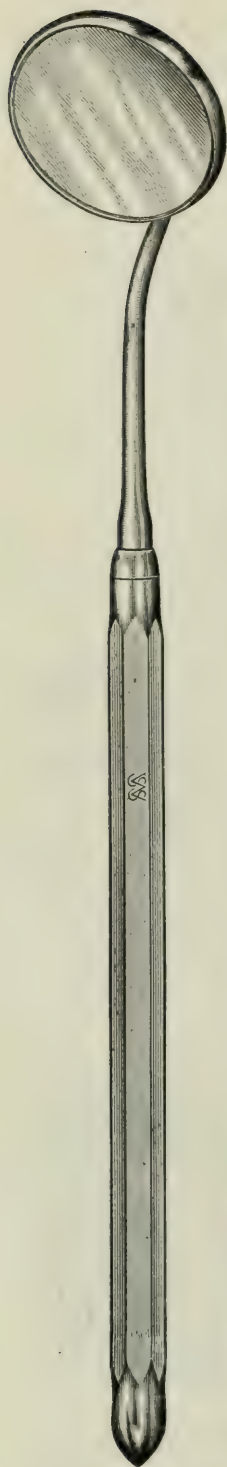


FIG. 116.—Mouth mirror with contra-angled shank.

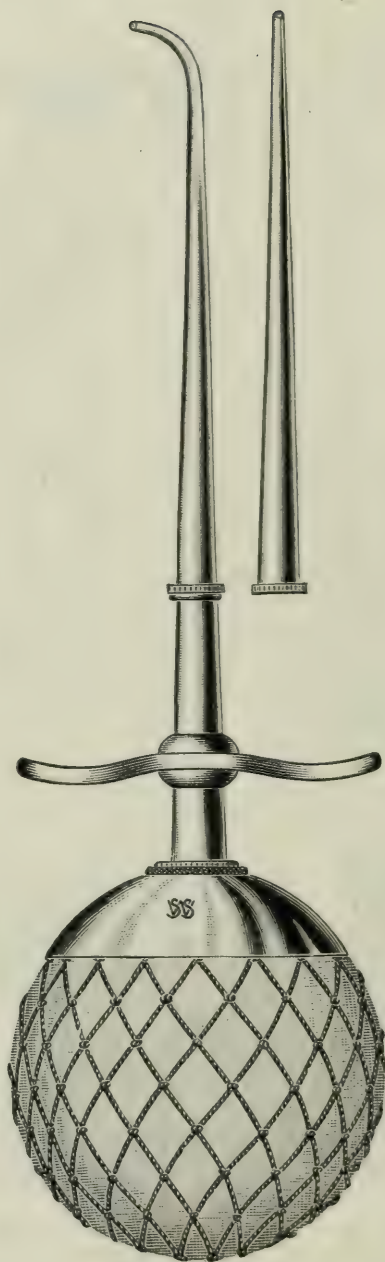


FIG. 117.—Water syringe with rubber bulb.

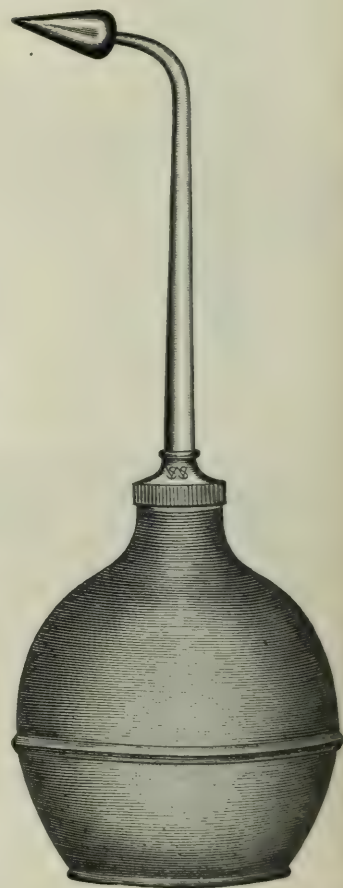


FIG. 118.—Chip blower.

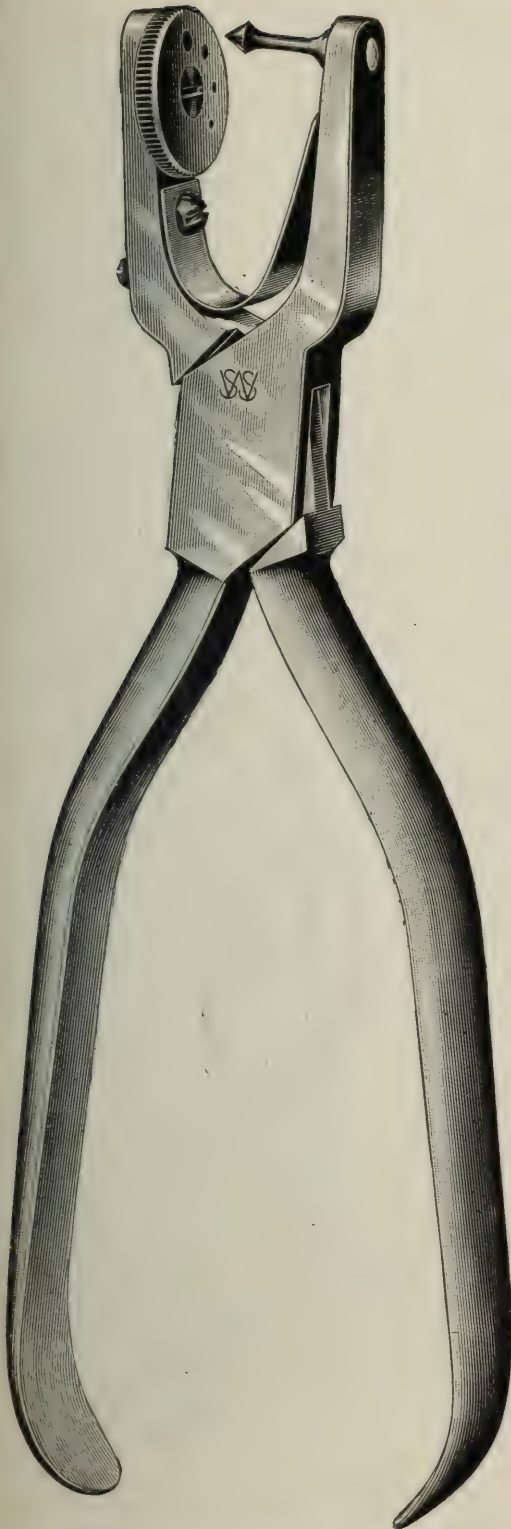


FIG. 119.—Ainsworth rubber dam punch.

(d) **Mirror.**—For reflecting the light into various parts of the mouth and for reflecting the images of cavities, fillings and other objects in inaccessible positions, the mouth mirror, either plane or magnifying is utilized (Fig. 116). For general work, the *plane* mirror (non-magnifying) is best, while for examining purposes the *concave* (magnifying) mirror may be used.

Various forms of scissors for cutting superfluous gum tissue, cotton, gold and rub-

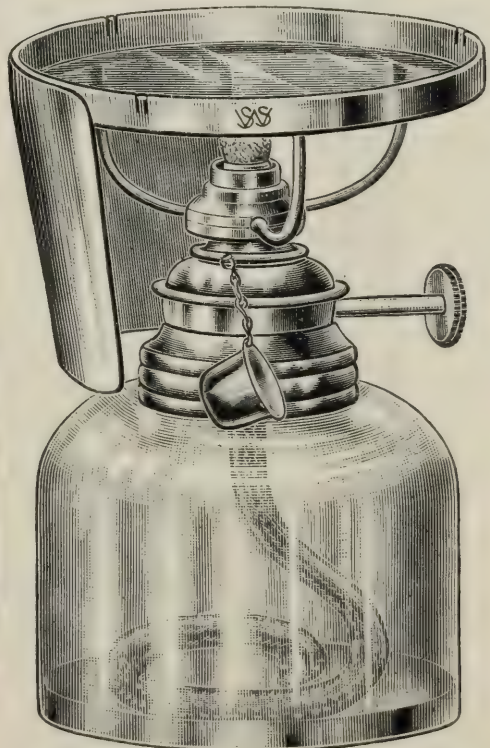


FIG. 120.—Alcohol lamp, flame shield and gold annealer.



FIG. 121.—Revolving head engine bur holder for laboratory use.

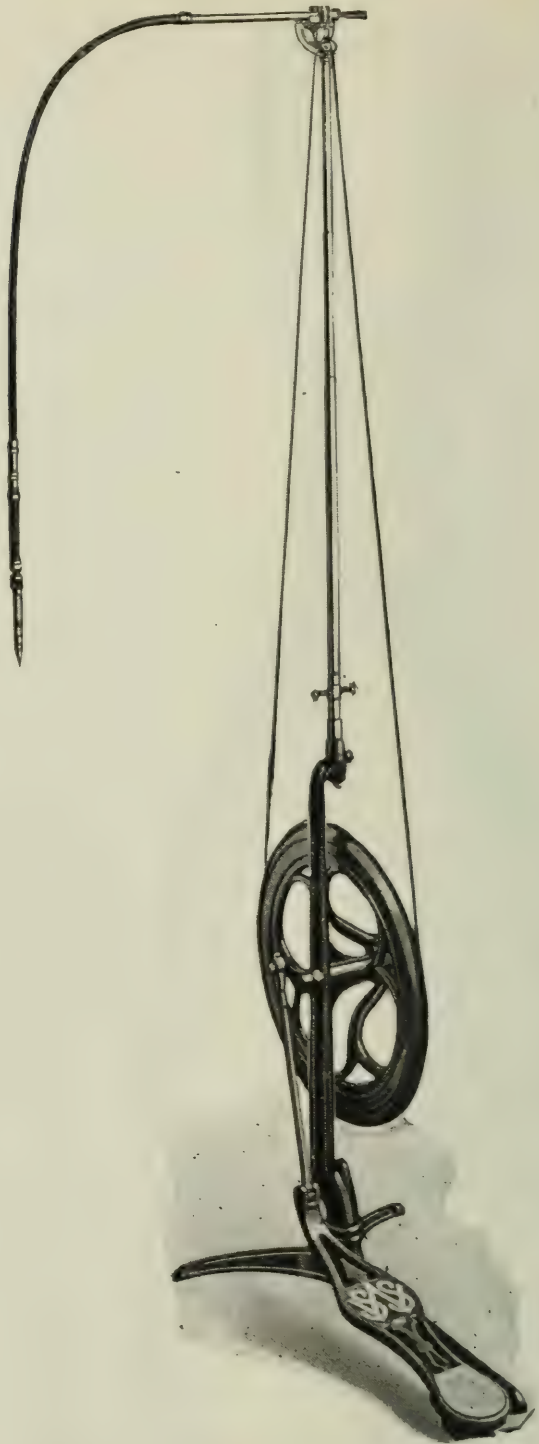


FIG. 122.—Student's dental engine.

ber; water syringes (Fig. 117): hot air syringes and chip blowers (Fig. 118) for drying and removing débris from cavities and canals; rubber dam punches (Fig. 119) for punching holes in the rubber cloth; as well as many other accessories and appliances, will gradually become familiar articles to the student, and will not be touched upon here (Figs. 120, 121 and 122).

INSTRUMENT MAKING

Object.—To gain a knowledge of the process of hardening, tempering and annealing steel; of the proper methods of shaping and sharpening tools; of the reason for placing the various angles in the shanks; as well as gaining a familiarity with the class, subclass, order and formula names of the instruments.

Instrument blanks may be obtained from the various dental instrument manufacturers—either in long-handle or cone-socket forms. The blanks are *annealed*, but should be re-annealed by the student before beginning the technic exercises in instrument making. The amount of technic work to be done will be regulated by the time at the disposal of the class. Where time will not permit of the making of a set of cutting instruments in steel, at least 6 or 8 long-handled instruments should be constructed, the balance of the work being done on annealed brass wire, 13-gauge, cut to 6-inch lengths. The student should make a complete set of the hand cutting instruments as used in the operative clinic of the college.

Technic Work in Steel. Instruments required.—

1. Blowpipe, foot bellows and tubing, or Bunsen burner
2. Bench vise
3. Pliers (round-nose and flat-nose)

4. Carborundum stones and chuck for lathe
5. Arkansas stone
6. Anvil
7. Hammer
8. Metal file
9. Instrument gauge
10. Felt cones and brush wheels for lathe
11. Emery paper and polishing powders.

Directions for Making Steel Excavators and Chisels

1. *Annealing*.—Select the blank of proper size and with the blowpipe or Bunsen burner heat the point and shank to *full cherry red* and allow to cool slowly. This anneals it and makes it soft and pliable.

2. Place the instrument to be duplicated, or a picture of it, together with a memorandum of its formula, before you.

3. With the millimeter gauge see if that portion to be made into the blade will need any change in form or dimensions; if so, procure the needed change with hammer and anvil or the file.

4. If necessary, file the shank down to the proper measurement and taper.

5. *Angling*.—Bend the shank by means of the pliers till the proper angles, as mon-angle, bin-angle, triple-angle, contra-angle, etc., are procured, as indicated by its formula, verifying them with the instrument gauge and by comparing with the model to be duplicated.

6. *Beveling*.—File the cutting edge of the blade to the proper bevel, verifying all dimensions with the millimeter gauge.

7. *Preliminary Polish*.—Remove all file marks with fine emery paper, then take to the lathe and give a high polish, first using pumice on a felt cone or wheel and later whiting and water.

8. *Hardening*.—Cover with soap, heat to a *full cherry red* color and plunge immediately in *cold* water. Be careful not to overheat the blank. Better underheat it, for if overheated the carbon is burned out and the instrument will not take a fine edge.

9. *Testing*.—Test with a file for proper hardness. If the file attacks the metal it is too soft. If this is the case, reheat as before and again plunge.

10. *Secondary Polish*.—Polish again according to the directions already given.

11. *Tempering*.—Place the shank of the instrument in the flame and heat to a *faint yellow* or *straw color*, plunging immediately in *cold* water or other media as indicated.

12. *Tertiary Polish*.—Polish again to remove the oxides formed on the surface, so that the colors may again be seen to appear in case of subsequent tempering.

13. *Spring Temper for Shank*.—Cover with soap and place the blade of the instrument in contact with a hammer or some other large piece of metal, so that it will conduct away the heat and prevent drawing the temper already given the blade. Place that portion of the shank back of where the temper is required in the flame, heat and watch closely for the *blue color*, on the appearance of which, plunge immediately as before.

14. *Sharpening and Final Polish*.—Again polish, and sharpen the blade for use.

Technic Work in Brass.—If the instruments are made in brass, practically the same procedures are followed, except that no hardening or tempering is required and the polishing is done only on completion of the work. The brass should be first annealed, when it is ready for the various manipulations (Fig. 123).

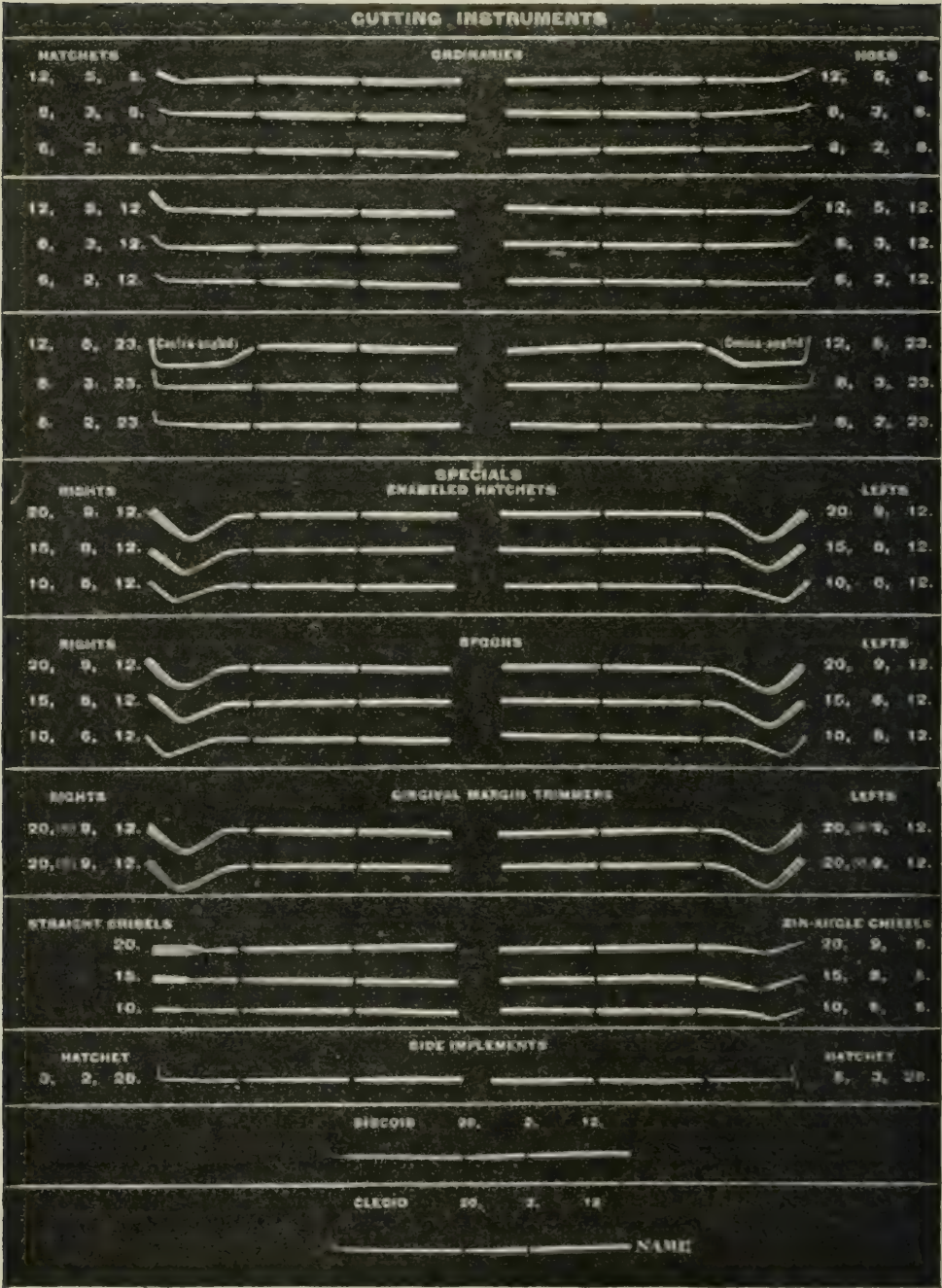


FIG. 123.—Set of instruments made from brass wire as used at Northwestern University Dental School. Courtesy of Dr. Fred W. Gethro.

CHAPTER III

PRELIMINARY TECHNICAL PROCEDURES MOUTH HYGIENE AND ORAL PROPHYLAXIS— EXAMINATION OF THE PATIENT

Mouth Hygiene and Oral Prophylaxis

Mouth Hygiene.—That branch of sanitary science which treats of the health of the mouth, and its preservation.

Oral Prophylaxis.—That branch of dental science which has for its object the preservation of the health and cleanliness of the oral cavity; viz.: *preventive dentistry*.

The deposits occurring in the mouth may be mentioned as follows, viz.:

1. Calculus (Salivary and Serumal)
2. Food Dèbris (recent, fermenting or putrefying)
3. Dead Epithelial cells
4. Bacterial Plaques
5. Mucin
6. Green stain
7. Chromogenic Bacterial stains
8. Tobacco, tea, coffee and medicinal stains

As a result of these deposits, grave local and systemic disturbances frequently arise. Among the **local** effects may be mentioned caries, fetid breath, gingivitis, stomatitis, pyorrhea, pulp diseases, alveolar abscess, pericementitis, osteitis, periostitis, osteomyelitis, bone necrosis, and diseases of the antrum. The above mentioned conditions, present in the mouth as a result of uncleanness and infection, are designated under the general term "*Oral Sepsis*."

The **systemic** effects likely to arise as a result of these local pathological conditions may be classified as follows, viz.:

(1) *Throat affections*: such as tonsilitis, pharyngitis, laryngitis, angina, diphtheria, abscess of the cervical glands.

(2) *Infections of the middle ear and Otolgia*.

(3) *Diseases of the eye*; such as iritis, conjunctivitis, keratoscleritis, optic neuritis, strabismus, amblyopia, glaucoma, paralysis of accommodation, spasms of the muscles of the lids, paresis and many others.

(4) *Diseases of the stomach, intestines, respiratory apparatus and viscera*; such as dyspepsia and indigestion, gastritis, constipation, diarrhea, abscess of the liver, pneumonia, bronchitis, tuberculosis and many others.

(5) *General constitutional disturbances*; such as lowered vitality, anemia, gout, rheumatism and the diseases of sub-oxidation, as well as abscesses, septicæmia, pyæmia, and septic infections in general.

(6) *Reflex nervous disorders* of the eye, ear, face and far distant parts.

(7) *Lowered mental vigor*, especially in children, as well as chorea, neurasthenia, epilepsy.

The avenues by way of which infection in the mouth may travel to distant parts are the blood and lymph streams, the mucous tracts (eustacion tube, etc.), the respiratory tract (inhalation), the digestive tract (deglutition), fascia of muscles and also by continuity of tissue. As a final result of these local and systemic disturbances, certain definite *psychological effects* may present, especially in children, such as vicious temper, untruthfulness, incorrigibility, degeneracy, melancholia, and criminal tendencies.

The treatment of these disturbances is both *preventive* and *curative*. The *Preventive Treatment* is as follows:

(1) Instruct patients as to the importance of the subject, bringing out its relation to the local and constitutional diseases mentioned.

(2) Give them explicit directions as to the care of the mouth, mentioning definitely by name the proper brush and dentifrice to use and how and when to use them.

(3) Have them visit you at regular intervals for local treatment.

The following instructions should be given patients with reference to the toilet of the mouth:

(1) Brush the teeth and *gums* at least three, better four times a day.

(2) Brush all surfaces of every tooth, paying special attention to occlusal surfaces of bicuspid and molars, lingual surfaces of all teeth and the wisdom teeth.

(3) Brush with a rotary *up and down*, as well as a cross-wise motion, reaching well into the inter-proximal embrasures.

(4) Cleanse the *inter-proximal spaces* with floss silk.

(5) Scrape the tongue with the brush or a *tongue scraper*.

(6) If the mouth and teeth are healthy and given regular attention, the use of a dentifrice is not necessary more than once a day.

(7) If regular and careful attention is not given, or if pathological conditions exist, use a colorless paste or powder and, in addition, gargle or spray the mouth and throat for several minutes with a colorless wash.

The *Curative Treatment* consists in the removal of all deposits and infection from the oral cavity, together with general tonic and alterative medication, exercise, baths, fresh air, diet and rest. Salivary calculus is found in largest amounts on the crowns of the teeth opposite the ducts of the salivary glands, on the lingual surfaces of the lower incisors and buccal surfaces of the upper molars. Serumal or sub-

gingival calculus, which is the most harmful, is located at and under the free margins of the gum.

The *method of removal* of these deposits by the dentist may be briefly described as follows:

(1) Rinse or spray the mouth with an antiseptic solution at the beginning and at intervals throughout the operation.

(2) Remove the gross deposits with the larger size scalers; avoid injuring the enamel.

(3) With small scalers of suitable shape, remove the small deposits on the crowns and at the necks of all the teeth, working well under the gum, but avoiding wounding the soft tissues.

(4) Carry the small delicate scalers well to the bottom of any "pockets" present, scraping thoroughly the exposed cementum of affected roots.

(5) With orange wood or basswood sticks, trimmed to suitable sizes and shapes, or wood points in a mandrel or porte polisher (Fig. 123A), go over the surfaces of crowns and exposed roots and thoroughly smooth and polish them with a paste of pumice mixed with Glycerine. Painting the teeth with dilute tincture of Iodine (disclosing stain) will exhibit to view any bacterial plaques present. Hydrogen dioxid will bleach and greatly assist in the removal of green and other stains.

DISCLOSING SOLUTION

Formula of Dr. F. H. Skinner

Iodine crystals.....	gr. 0.15
Potassium iodide.....	gr. 0.15
Zinc iodide.....	gr. 0.15
Glycerine.....	dr. 0.4
Aqua.....	dr. 0.4

This solution should be kept in a glass stoppered bottle.

(6) Polish the proximal surfaces with ribbon dental floss (Cutter's) carrying the pumice mixture.

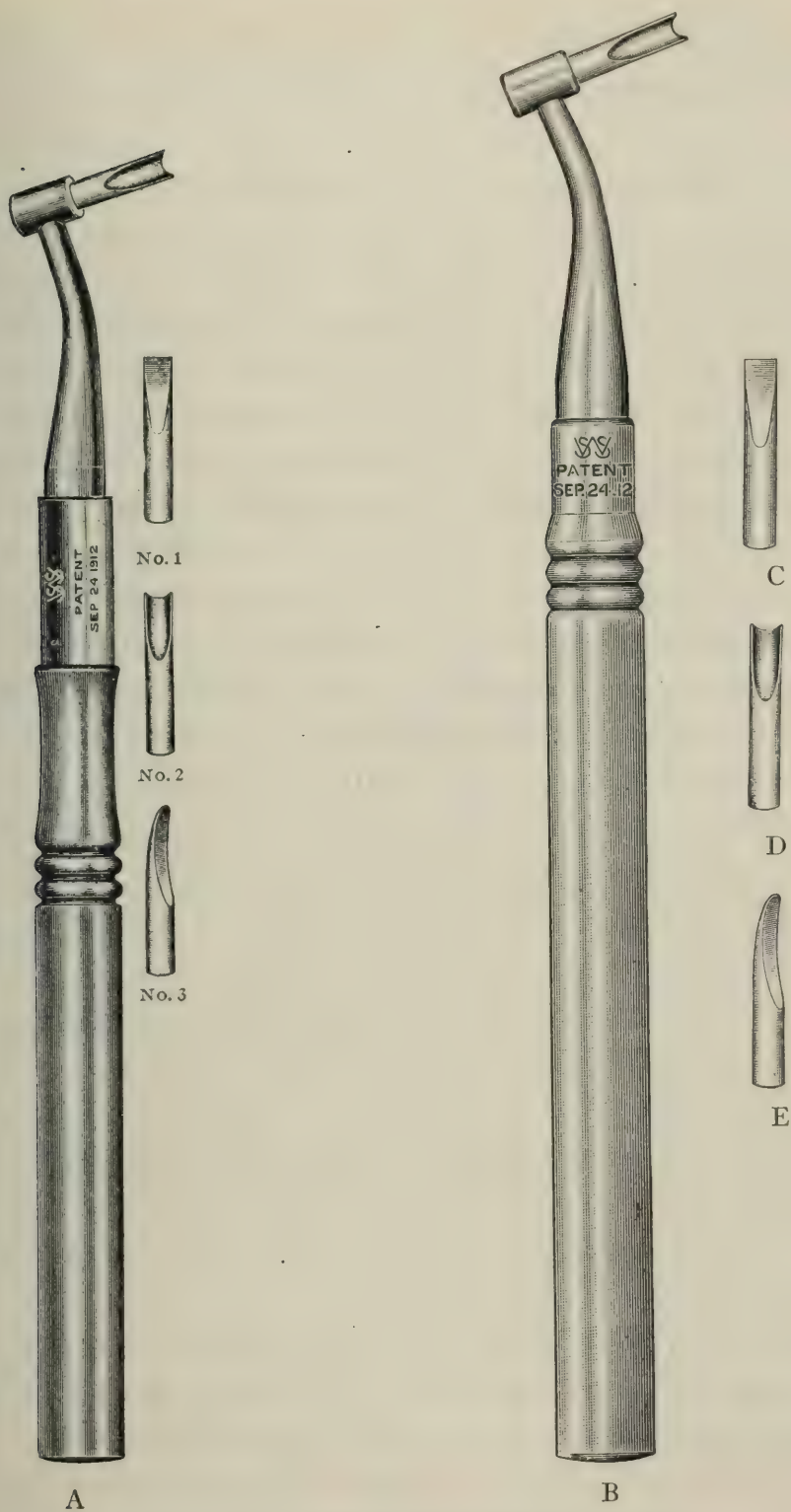


FIG. 123A.—Hand porte polishers and points.

(7) Repeat the process of polishing with a finer polishing powder such as oxid of tin or prepared chalk.

EXAMINATION OF THE PATIENT

The examination of the patient should be very carefully conducted, including, in addition to a close inspection of the teeth and supporting structures, a general inspection of the patient. Such details as physical appearance, the general state of health, manner of speech and carriage and similar conditions should be noted. The minutest defects about the teeth should be detected and recorded, in order that they may receive immediate attention, since it is a great mistake to defer these until a later date. They can be remedied in their inception with much less pain to the patient and trouble to the operator and will thus enable the patient to maintain more readily a hygienic condition of the oral cavity.

Frequently the teeth should be thoroughly scaled and polished before proceeding to the examination, thus placing them in a cleanly condition and rendering the examination easier and surer. Drying the surface of the tooth to be examined with a pledget of cotton, the chip blower, or alcohol and hot air, is often advisable to make clearer the view and assist in the diagnosis. On proximal surfaces the use of the rapid separator will occasionally be needed before the presence or absence of pathological disturbances can be determined.

The correct position of the operator for examining or operating on the teeth is as follows:

(1) He should, as far as conditions will allow, stand in an upright position, with his shoulders thrown back and his chest forward, to avoid the tendency to stoop shoulders.

(2) The weight of his body should rest firmly on the balls of his feet, rather than on his heels.

(3) The points of bodily contact with the patient should be as few as possible: as a rule only those secured by the correct application of the *rest* and *guard*.

(4) He should breathe deeply, slowly and naturally, through the nose, avoiding inhaling the patient's breath, or exhaling into his face.

The correct position of the chair may be described as follows:

(1) *For the upper teeth* the chair should be tilted more or less backward (in order that a better view may be obtained), and elevated to a greater or less extent (depending on whether the anterior or posterior teeth are concerned), to suit the convenience of the operator.

(2) *For the lower teeth* the patient should be in the upright position, so that the light may be thrown directly onto their surfaces, with the chair lowered.

Children should usually be examined at intervals of about three or four months, while adults should receive attention at least twice a year. However, in cases of pyorrhea and similar disturbances it is often advisable to see the patient at more frequent intervals. Explorers, mouth mirrors (plane and concave), floss silk, magnifying glasses (hand or jeweler's), the chip blower, absorbents and the electric mouth lamp are all valuable adjuncts.

The regions or localities requiring specially close inspection are:

(1) *Lines of union* of enamel plates, such as pits and fissures on occlusal, buccal and lingual surfaces.

(2) The *gingival region*, at and beneath the gum margin.

(3) *Proximal surfaces*, especially near and gingivally to the contact point, where decay most frequently begins on these surfaces.

(4) *Margins* of fillings, inlays and crowns.

As each defect is located, its position and character, as well as the probable treatment, should be marked on a record containing a chart of the permanent and deciduous teeth (Fig. 124). In locations where trouble is suspected, but not positively diagnosed, a question mark may be placed as a reminder, when a closer inspection may later be made in that locality. The use of the chart will frequently facilitate the discussion of

Date _____ 19__



Examination of M _____

teeth.

Remarks: _____

FIG. 124.—Examination chart.

fees where deemed advisable, the extent and location of the conditions requiring treatment may be readily explained to the patient and also, by this means, the operator is afforded a ready reference at each visit of the patient as to work requiring attention.

Various authorities recommend different methods. All agree that a definite and systematic course of procedure of

making the examination should be adopted and regularly followed. The author recommends the following method:

1. *General Physical Inspection*.—Note the carriage, general bearing and physical appearance, complexion, color of lips, hair, nails and eyes; general health; condition of pulse if desirable; manner of speech; inquire for presence or absence of pain.

2. *Examination of the Soft Tissues of the Mouth*.—Note the color and condition of the mucous membrane of lips, cheeks and gums; presence or absence of swellings, tenderness or abscess tracts; general hygienic condition, as far as deposits are concerned; condition of tongue, whether coated or furred. The X-ray is a valuable adjunct in later detecting and diagnosing obscure conditions.

3. *Lower Teeth*.—Start at the third molar on the left side and examine the buccal, occlusal and lingual surfaces, in the order mentioned, of each tooth separately, coming forward to the median line. Repeat the procedure on the *right* side. Then examine the approximal surfaces in the same order.

4. *Upper Teeth*.—Follow the same course.

It may now be seen that the examination of patients applying for dental attention should not be the cursory procedure frequently observed by many practitioners. Recognition of the existence of oral foci of infection and their far-reaching influence on the health and well-being of the entire organism, as well as increasing knowledge of many vague manifestations of reflex disturbances, associated with oral pathological conditions, have become of such importance in their bearing on the practice of dentistry, that it is difficult to foretell what is to be the future status of the profession.

The author, whose private practice consists largely in the diagnosis and treatment of referred patients, suffering with disturbances of a vague nature, now makes an extremely

minute examination of his patients, including personal and family history, blood, salivary and urinary tests, pathological, bacteriological, serological, immunological, and toxicological analyses, as well as radiographic and oral inspection. These procedures may not be always necessary in the handling of routine cases, but for diagnosis of masked conditions, the value of many of them may be readily recognized.

CHAPTER IV

PRELIMINARY TECHNICAL PROCEDURES

(Continued)

SEPARATION OF THE TEETH—EXCLUSION OF MOISTURE—USE OF THE MATRIX

Separation of the Teeth

Nature has designed two forms of contact between approximating teeth—one, the small marble contact, the ideal form—the other the broad contact, far from ideal, and found usually in connection with thick-neck teeth.

The contacts are situated at the points of the V-shaped inter-proximal spaces, which latter are normally filled with gum tissue. In cases of bell-crowned teeth and marble contact points, which are the ideal forms, the base of the inter-proximal V is broad, the proximal surfaces of the teeth forming the V receding well away from each other. With thick-neck teeth and broad contact surfaces, the inter-proximal space is much narrower, the base of the V being very short.

As a result of age and inter-proximal wear, the contact points are frequently worn flat, with the result that the teeth have drifted together and the total length of the arch has been shortened, thus lowering the power of the entire masticating machine. The same conditions are likely to occur from improper inter-proximal dental operations with inadequate contours and contact point restorations. The dentist should be careful in every instance, where proximal fillings are made to see that the teeth are lifted apart, through adequate

separation, and that original contours are restored and ideal contact points built. Nature does not always produce ideal forms, consequently it is frequently possible for the dentist to improve on nature in this regard.

Failure to properly restore inter-proximal contours and contact points is a very frequent cause of gingivitis and pyorrhea alveolaris, as a result of the packing of food masses into the spaces, these masses either acting as mechanical irritants, or later fermenting or putrefying, with resultant chemical and bacteriological irritation to the highly sensitive and delicate gum septum.

Dr. G. V. Black has given five reasons for maintenance of normal V-shaped inter-proximal spaces, as follows:

- (1) For conservation of healthy gum tissue.
- (2) To prevent inpaction of food.
- (3) To enable patients to most readily accomplish the cleansing operation.
- (4) To insure permanence of fillings.
- (5) For esthetic appearance.

Separation of the teeth is a much more important procedure than it would appear to be on first thought. It is occasionally necessary for proper examination of interproximal spaces. In the majority of instances, this may be readily accomplished by means of the rapid separator. It is necessary for proper restoration of anatomical contours and normal contact points in fillings and also for preservation of healthy inter-proximal gum tissue.

There are two general methods of producing separation, one of which is known as *slow* or *previous* and the other as *rapid* or *immediate*. Each of these methods has its advocates and the two are often combined under special circumstances.

The advantages and disadvantages of the slow method are as follows, viz.:

1. *Advantages:*

- (a) Comparative lack of soreness, except with rubber.
- (b) Diminution of danger to the fibres of the pericementum.
- (c) Ability to temporarily force away, with gutta-percha, swollen gum tissue from gingival margins.

2. *Disadvantages:*

- (a) Slowness.

The advantages and disadvantages of immediate separation may be mentioned as follows:

1. *Advantages:*

- (a) Quickness.
- (b) Steadying or prevention of movements of the teeth during the filling operation.

2. *Disadvantages:*

- (a) Danger of rupture of the pericementum and permanent loosening of the teeth.
- (b) Pain.

The materials used in slow separation are:

1. Gutta-percha (base-plate or any variety of permanent gutta-percha).
2. Cotton (dry and frequently changed).
3. Wood (orange wood or hickory).
4. Linen tape (covered with wax or chloro-percha).
5. Rubber (rubber dam, orthodontia bands or separating strips).
6. Cork.

Following is a brief description of the method of use of these materials:

1. *Gutta-percha*.—Pack the cavity over full, avoiding the danger of too much pressure on the gum, and instruct the

patient to use the tooth vigorously. Leave in position for several days or weeks and renew if necessary.

2. *Cotton*.—(a) Twist the dry cotton into a small rope and force in between the contact points, cutting off protruding ends.

(b) Or in case of a large cavity, pack as full as possible.

(c) Or pass a ligature into the inter-proximal space, allowing it to rest on the gums, when, after the adaptation of the cotton, tie it in place, making the knot over the contact points.

(d) Or tie a pledget of cotton in the center of a ligature, draw it into place in the inter-proximal space and tie into position as before.

3. *Wood*.—(a) Trim an orange wood stick into a wedge of suitable size and shape, force carefully into position and cut off the excess with wedge-cutting forceps.

(b) Or cut a deep notch in the wood where it is desired to remove the excess, and after insertion of the wedge break it off at the location of the notch.

4. *Linen Tape*.—Force the tape into position and cut off the excess with scissors. Remove it in a day or two and insert a thicker piece, or double it upon itself, continuing in this manner until the desired space is secured.

5. *Rubber*.—Its use is undesirable in the majority of cases, on account of the soreness produced. If used for special reasons, stretch and force into position just beyond the contact points, avoiding pressure on the gums. Remove the excess with a pair of scissors and allow it to remain in position from 12 to 24 hours. If extreme soreness is produced, maintain, by means of gutta-percha, the separation gained, until all soreness subsides. Rubber separating strips should usually be avoided for this purpose, using preferably a small strip of rubber dam or orthodontia band.

6. *Cork*.—Force properly shaped pieces of cork into position, increasing the size at each visit, until the desired result is obtained.

The rapid separator is quite largely used today. Among the more prominent ones may be mentioned the Ivory Universal, the Ivory Double-bow, the Ivory Adjustable, the Perry (set of six), the Perry Universal and the Elliot. One or the other of these separators is frequently valuable for the following purposes:

1. For examination of inter-proximal spaces,
2. Preparatory to slow separation,
3. To maintain space gained by previous separation,
4. For preparation of cavities,
5. For insertion and polishing of fillings and inlays,
6. For removal of foreign bodies, such as berry seeds, fragments of toothpicks or bone sequestra.

During its use the force should be applied very slowly and gradually, at the same time encouraging the patient by tactful methods. In cases where the teeth are exceedingly close and firmly implanted, it is wise not to force the instrument too much, but rather to adopt a combination of the rapid and slow methods.

EXCLUSION OF MOISTURE

There are two general methods of excluding moisture from the field of operation, (1) by the use of the rubber dam and (2) by application of absorbents and non-absorbents.

Exclusion of the secretions of the mouth from the field of operation and the production of absolute dryness are essential to the correct performance of most dental operations. This is necessary for the following reasons:

1. To secure cohesion of gold,
2. To perfect the view of cavities,

3. To prevent recurrence of decay under fillings,
4. To diminish pain,
5. To accomplish and maintain sterilization of cavities and canals,
6. To avoid discoloration during operations in canals,
7. To prevent disintegration of cements and gutta-percha,
8. To prevent dilution and spreading of medicinal agents.

The introduction of the rubber dam into dentistry by Dr. Samuel C. Barnum, of New York City, in 1846, resulted in great improvement in the technic of dental operations, and the advancement of dentistry as a profession consequently received a marked impetus. Moisture may be more readily and perfectly excluded with this adjunct than through the use of absorbents. The use of the latter should, as a rule, be confined to operations on the soft tissues of the mouth and very short or simple procedures on the hard structures. The rubber dam is in reality a *time saver*, since the slightly additional time required for its application is, in the majority of cases, over-balanced by the elimination of the troubles, inconveniences and seepages of moisture frequently arising during the use of absorbents. Many operators seem to have, in the beginning, a natural timidity in regard to its application, and are prone to attempt to dispense with it on that account. Frequent practice in its use will eliminate this feeling and result in efficiency in its application.

Rubber dam may be classified into light, medium, and heavy, depending on its thickness. Light-weight dam is easily applied, but is more readily torn; while heavy dam is more difficult to handle, but less readily injured. Medium weight is usually preferred, because it possesses the advantages of the other two varieties, with a minimum of the disadvantages mentioned. To test the purity of rubber dam, stretch it well over the end of the thumb or finger, when, if on relief

of the pressure, it returns to its original shape, without tearing or buckling, it is fit for use. It may be cut into triangular, oblong or square form. Cutting into triangular form is economical, this form being cut from pieces 6 to 9 inches wide. If the oblong form is used for anterior teeth, it should be about $3\frac{1}{2}$ to 4 in. in length, from its upper to its lower border. For molars the dam should be cut into square form and measure at least 5 inches from upper to lower border; while the size and shape for bicuspid should be intermediate between that for the anteriors and the molars. It should always be cut large enough to cover the upper lip and chin, but should not interfere with the nostrils.

For operations on the six anteriors, at least two teeth mesial and two distal to the tooth to be operated upon should be included. For the bicuspid of either side, include one or more of the molars and as far forward as the lateral, while for molar operations, make the application to include the bicuspid and at least one, or better two teeth distal to the one operated upon.

The following conditions regulate the width of space between the holes:

1. The space between the teeth (wide inter-proximal spaces, wide spaces between the holes),
2. The height of the gum festoon (large festoons or re-
ceded gums, large spaces),
3. The weight of the dam (light weight, large spaces),
4. The size of the teeth (large teeth, large spaces).

The average space should be from 2 to 4 mm. The size of the tooth will largely regulate the size of the hole to be cut.

Before and after removal of the dam, the following general rules should be observed:

1. Remove calculus and glutinous deposits and douche the teeth with warm water before applying the dam.

2. Test the contacts and cleanse the inter-proximal spaces with floss silk before application.
3. Remove with a thin spatula, chisel, or saw all jagged edges of enamel before application.
4. Be sure no ligatures or fragments of rubber are left in position after removal.
5. Flush with warm water and massage the gums after removal of the dam, to restore the circulation.

All of these procedures are desirable to insure easy adaptation of the rubber cloth and to prevent the tendency to injury or infection of the soft tissues.

To assist in the application of the dam there are a number of prominent sets of rubber-dam clamps, among which may be mentioned the Ivory, S. S. White, Palmer, Huey, and Black sets. For application over cervical cavities the Ivory, Keefe, Dunn, Hatch and Woodward cervical clamps are valuable. During the application of any of these clamps great care should be exercised to avoid wounding the gums and pericementum, damage to the enamel and production of pain (Fig. 125),

For short operations on the teeth three general methods may be utilized for the exclusion of saliva, viz.: *first*, by means of absorbent; *second*, by application of non-absorbents; and *third*, by the combined use of absorbents and non-absorbents. Among the absorbents may be mentioned cotton rolls, mouth napkins, cottonoid, lintine, absorbent cotton, bibulous paper, absorbent pledgets, and absorbent points (for drying canals). A non-absorbent is a specially prepared cotton, usually made in the form of rolls, used for occluding the salivary ducts and damming back the saliva. It is generally used in combination with absorbent rolls, a section of a non-absorbent roll being placed over the mouth of the duct, when absorbent rolls are placed over it and surrounding the tooth to be operated upon.

Cotton rolls are supplied in 6 inch and $1\frac{1}{2}$ -inch lengths, and in diameters of $\frac{5}{16}$, $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{5}{8}$ of an inch. The smallest size is designated as number one, the next largest as number

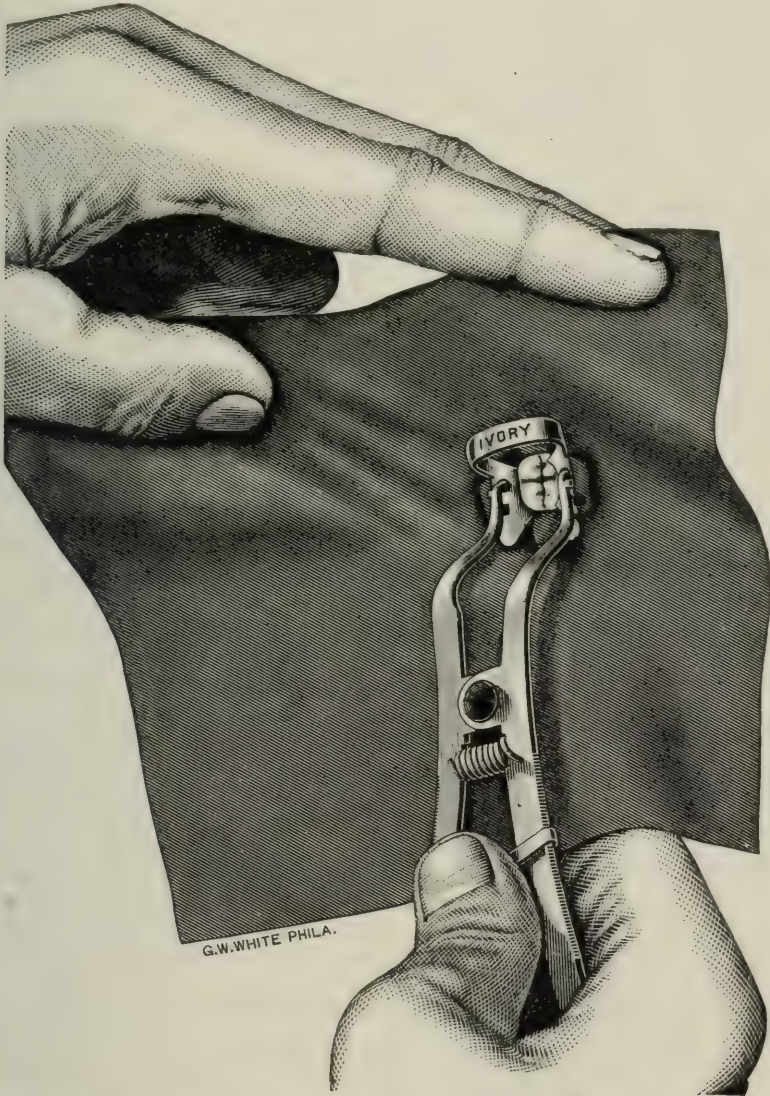


FIG. 125.—Applying the rubber dam, showing the rubber dam clamp and clamp forceps.

two, the next number three, while the largest is number four. For holding these in position the Ivory, Zimmerman or Simmons cotton-roll clamp is valuable.

THE MATRIX

The use of the matrix is essential to the proper contour of proximo-incisal or proximo-occlusal fillings of a plastic nature. There are many forms of matrix bands and retainers supplied by the manufacturer, but in special cases, the dentist may often adopt matrices of his own construction with better results.

Four important uses of the matrix are: *first*, to act as a temporary wall of resistance during introduction of the filling; *second*, to give shape to the restoration; *third*, to maintain the form of the filling during hardening or setting; *fourth*, to hold back the gum and rubber dam during introduction of the filling.

Numerous forms of patented matrix holders and bands may be obtained from the manufacturers, among which are the Ivory, Crenshaw, Hinniker, Jack, Brophy, Woodward, Lodge, Onderdonk and Hodson. Matrix bands are usually constructed of steel, phosphor bronze, copper, german silver or celluloid. In many instances the dentist may accomplish better results by constructing matrices for each individual case. Among numerous forms utilized for special cases may be mentioned the following: 1. *The Soldered Band*.—Made by taking a measurement of the neck of the tooth and soldering a band of metal to fit.

2. *The Tied Band*.—Clamp with pliers a piece of metal around the tooth, pinching the ends tightly together. Remove and tie at the point of juncture with binding wire, after which bend back the projecting ends and place in position on the tooth.

3. *Another Tied Band*.—Take a measurement of the neck of the tooth and cut a piece of metal of the proper length and width. Punch a hole near each end. Pass a ligature through

one hole, then along the length of the band, and back through the other hole. Place the band in position and tie to place, wrapping the ligature around the tooth several times if necessary.

4. *Wedged Matrix*.—Cut a piece of band metal of proper shape to supply the missing wall, and after ligating, wedge to place in the inter-proximal space with orange wood, to gain separation.

Matrices are essential for the proper introduction of amalgam, cement (including silicate) and gutta-percha into proximal cavities. Some operators use them for gold fillings, starting on the gingival wall with non-cohesive gold, but this method is not recommended by the author. Whenever the matrix is used, separation of the teeth is desirable, to allow for the space occupied by the matrix band, so that contact points may be restored and knuckled. For this purpose a small wooden wedge is valuable.

TECHNICAL EXERCISES

1. Apply the rapid separator in several localities on the typodont or other technic block.
2. Trim several wooden wedges and produce separation in different localities on the technic block.
3. Apply cotton rolls and napkins with the cotton-roll clamp to the technic block.
4. Adjust the rubber cloth in several localities on the technic form, with the use of ligatures and clamps.
5. Adjust the matrix to several teeth on the technic form.

CHAPTER V

PREPARATION OF CAVITIES

No attempt will be made here to enter into an extended discussion of the causes of decay of the teeth. Matters of this nature are fully covered in works on dental pathology. The following, however, is a brief statement of the manner in which cavities of decay are produced.

Causes of Decay.—Cavities occur in teeth as a result of decay beginning on their surface. Decay is largely the result of the **fermentation** of food debris. Fermentation is a decomposition of carbohydrates (starches, sugars, etc.). **Food debris** accumulates because of neglect in the application of the ordinary rules of cleanliness to the care of the teeth. Fermentation of food debris is due to the constant presence of **germs** in the mouth. The action of certain of these germs on the fermentable material produces **lactic acid**. Lactic acid dissolves out the **lime salts**, of which the major part of the tooth is composed. Other germs, constantly present, liquefy the **organic material**, which constitutes the remainder of the tooth. The result is a **cavity of decay**.

Definition.—By “preparation of cavities” is meant those procedures incident to the removal of decay and the shaping of the cavity, so that when filled, the tooth will be restored, as far as possible, to its original form and strength, and be immune from future decay in the same location.

Nomenclature.—A system of words, sounds or signs by which individuals of the same race, profession, or calling, are enabled to understand each other. The profession of dentistry has a nomenclature of its own. A study of the nomencla-

ture of cavity preparation is essential to an understanding of the contents of the following chapter.

Angle.—The union of two surfaces along a definite line (*line angle*) or of three surfaces at a point (*point angle*).

Cavo-surface Angle.—The angle formed by the junction of the walls of the cavity with the surface of the tooth.

Axial Line Angle.—A line angle running parallel with the long axis of the tooth.

Pulpal Line Angle.—One running horizontally to the long axis of the tooth.

Wall.—One of the internal boundaries of a cavity.

Margin.—The junction of the walls of a cavity with the surface of a tooth.

Marginal Outline.—The shape of the cavity along its margins.

Dento-enamel Junction.—The line representing the junction of the enamel and dentin.

The nomenclature of cavity preparation followed and now considered official is that adopted by the **Institute of Dental Pedagogics**, from the report of a committee of which Dr. Thomas E. Weeks was Chairman, as follows:

CAVITY NOMENCLATURE

All that is to be said in describing cavity preparation can be expressed by the use of the following nouns and adjectives:

Cavity	Surface	Labial	Mesial	Gingival
Wall	Angle	Buccal	Distal	Axial
Margin	Thirds	Lingual	Incisal	Pulpal
Plane	Embrasure	Proximal	Occlusal	Subpulpal

Cavity Names

Cavities in the teeth take the names of the surfaces in which they occur.

Cavity	Simple	{	Labial
		{	Buccal
		{	Lingual
		{	Mesial
		{	Distal
		{	Occlusal
	Complex	{	Mesio-incisal
		{	Disto-incisal
		{	Mesio-labial
		{	Disto-labial
		{	Mesio-lingual
		{	Disto-lingual
		{	Mesio-occlusal
		{	Disto-occlusal
		{	Linguo-occlusal
		{	Bucco-occlusal
		{	Mesio-disto-occlusal
		{	(Other combinations by the same rule)

Wall Names

That wall of a cavity in an axial surface of a tooth that covers the pulp is called the *axial* wall. If the cavity is extended to include the pulp chamber this wall takes the name of the wall of the pulp chamber. The bottom or floor of occlusal cavities is called the *pulpal* wall. If extended to include the pulp chamber it becomes the *subpulpal* wall.

Wall	Labial
	Buccal
	Incisal
	Occlusal
	Lingual
	Mesial
	Distal
	Gingival
	Axial
	Pulpal
	Subpulpal

Rule.—Cavity walls take the names of the surfaces of the tooth which they approach.

Angles (Simple Cavities)

Angles	Line (Axial)	Mesio-buccal	}	Occlusal cavities
		Mesio-lingual		
		Disto-buccal		
		Disto-lingual	}	Axial surface cavities
		Bucco-axial		
		Linguo-axial		
	Line (Pulpal)	Mesio-axial	}	Occlusal cavities
		Disto-axial		
		Bucco-pulpal		
		Linguo-pulpal	}	Occlusal cavities
		Mesio-pulpal		
		Disto-pulpal		
		Bucco-gingival	}	Axial surface cavities
		Linguo-gingival		
		Mesio-gingival		
		Disto-gingival	}	Axial surface cavities
		Axio-gingival		
		(and combinations with occlusal wall)		
	Point	Mesio-bucco-pulpal	}	Mesio-linguo-pulpal
		Disto-bucco-pulpal		Disto-linguo-pulpal

Point Angles (the union of three-line angles) take their names from the surfaces forming them. In occlusal cavities there are four.

In complex cavities on axial surfaces there is another horizontal line angle, *i.e.*, in axial cavities combined with occlusal, the one formed by union of the axial and the pulpal wall—**axio-pulpal**.

Division into Thirds

Cavities may be divided into thirds, for convenience in description, as teeth are divided.

Names of Margins

Margins	Mesial
	Distal
	Buccal
	Labial
	Lingual
	Incisal
	Occlusal
	Gingival

Nomenclature of Simple Cavities

Occlusal Cavities		Labial, Buccal or Lingual Cavities	
Walls	Mesial	Walls	Mesial
	Distal		Distal
	Buccal		Gingival
	Lingual		Occlusal or incisal
	Pulpal		Axial
Line angles (longitudinal)	Mesio-buccal	Line angles (longitudinal)	Mesio-axial
	Mesio-lingual		Disto-axial
	Disto-buccal		
	Disto-lingual		
Line angles (transverse)	Mesio-pulpal	Line angles (transverse)	Mesio-occlusal
	Disto-pulpal		Disto-occlusal
	Linguo-pulpal		Mesio-gingival
	Bucco-pulpal		Disto-gingival
			Occluso-axial
Cavo-surface angles	Mesio-occlusal	Cavo-surface angles	Gingivo-axial
	Disto-occlusal		
	Bucco-occlusal		Based on the same rule as for occlu- sal cavities
	Linguo-occlusal		
Point angles	Mesio-bucco-pulpal	Point angles	Mesio-axio-gingival
	Disto-bucco-pulpal		Disto-axio-gingival
	Mesio-linguo-pulpal		Mesio-axio-occlusal
	Disto-linguo-pulpal		Disto-axio-occlusal
	Mesial		
Margins	Distal	Margins	Mesial
	Buccal		Distal
	Lingual		Gingival
			Occlusal or incisal

Simple cavities on proximal surfaces have the same number of walls, angles, and margins as those on other axial surfaces, and are named similarly.

With this basis all cavities, however complex, may be easily named and described.

CAVITY CLASSIFICATION, NOMENCLATURE, AND PREPARATION¹

Classification

Cavities.	{ Pit and fissure (no extension for prevention).	{ Cavities in the lingual surfaces of upper incisors.
		{ Cavities in occlusal surfaces of bicuspid and molars.
		{ Cavities in the occlusal two-thirds of the buccal and lingual surfaces of molars.
		{ Cavities in the gingival third of the labial, buccal, and lingual surfaces.
	{ Smooth surface (extension for prevention).	{ Cavities in proximal surfaces of incisors and cuspids which do not involve the mesial or distal incisal angle.
		{ Cavities in proximal surfaces of incisors and cuspids which do involve the mesial or distal incisal angle.
		{ Cavities in the proximal surfaces of bicuspid and molars.

Note.—Cavities occurring in consequence of arrested development are not included.

Another classification of cavities, based on the surface on which they are situated, is also frequently used and is herewith given.

Classification of Cavities

(a) Simple Cavities	{ Labial
	{ Buccal
	{ Lingual
	{ Mesial
	{ Distal
	{ Occlusal
(b) Complex Cavities	{ Mesio-incisal
	{ Disto-incisal
	{ Mesio-labial
	{ Disto-labial
	{ Mesio-lingual
	{ Disto-lingual
	{ Mesio-occlusal
	{ Disto-occlusal
	{ Linguo-occlusal
	{ Bucco-occlusal
	{ Mesio-disto-occlusal
	{ Mesio-disto-incisal

¹The above tables on cavity nomenclature were published in the American Text-book of Operative Dentistry, to the publishers of which acknowledgment is here extended.

STEPS IN CAVITY PREPARATION

1. Establish the outline form.
2. Remove the decay.
3. Give the cavity proper form

{	(a) Convenience form. (b) Resistance form. (c) Retention form.
---	--
4. Bevel and polish the enamel margins.
5. Perform the toilet of the cavity.

1. Establish the Outline Form.—Carry the marginal outline to the location which it will occupy on the completion of the cavity. This procedure, and *not the removal of the decay*, should be the first thought to enter the reader's mind, for reasons which will be understood better as he progresses.

Rule 1.—*Extend the margins until solid tooth structure, free from decay, is reached.*

Rule 2.—*Leave no overhanging enamel margins unsupported by dentin.* The enamel of the tooth is extremely brittle, owing to its histological structure, and depends for its strength on the support which it receives from the underlying dentin.

Rule 3.—*In fissure cavities, extend the margins to include the entire fissure.* Pits and fissures are extremely liable to decay, and if this rule is not followed decay is liable to occur in that part of the fissure not included in the cavity, with a consequent undermining of the filling.

Rule 4.—*Extend the margins of cavities approaching closely to deep developmental grooves, to include the grooves* for reasons of strength, as well as for the reason given in Rule 3.

Rule 5.—*Unite two cavities approaching closely to each other,* to prevent the leaving of a weak ridge of tooth structure between them.

Rule 6.—*Extend the gingival margins of cavities occurring in the gingival third of labial, buccal and lingual surfaces under the free margin of the gum,* where they will be less liable to decay.

Rule 7.—*In proximal cavities extend the labial, buccal and lingual walls well out into the embrasures, into areas where they will be less likely to decay; the incisal or occlusal margins beyond the contact point; and the gingival margins under the free margin of the gum.* The extension of these margins, as laid down in this rule, follows the law known as “extension for prevention,” which requires a brief explanation at this time.

Extension for Prevention

Proximal surfaces of the teeth are much more subject to decay than other portions, because **food** and **germs** accumulate more readily here, and are less easily removed. This being the case, if the margins of cavities are left in these **vulnerable areas**, they will be much harder to keep clean, and hence decay is likely to **recur** readily. Recognizing this fact, it is the accepted practice to **extend the margins** of cavities, when they occur in these areas, by cutting away enough of the tooth substance to carry them out to locations where the food is not so liable to deposit, and where they may be more readily cleansed. The food does not accumulate under the gum margin so much as it does a short distance occlusally to this point, hence the reason for **extension of the gingival margins**. Food accumulates very readily and frequently remains just **gingivally to the contact points** of two approximating teeth, and in order to obviate the necessity of leaving the incisal or occlusal margins within this vulnerable area, these margins are carried beyond this point down toward the **incisal, or occlusal surface**, where they can be more readily cleansed. **Buccal and lingual margins**, for the same reasons, are extended out **into the embrasures** for a certain distance, depending on the convexity of the tooth surface and the character of approximation.

Owing to the conditions under which operations are performed in the mouth, it is not always possible or advisable to extend cavity margins as described under the law of extension for prevention. The conditions which may modify this operation are the following:

1. A family history of lack of susceptibility to caries.
2. A personal history of similar non-susceptibility.
3. Presence of a period of immunity.
4. Lowered vitality from sickness, convalescence, pregnancy, adolescence and similar causes.
5. Personal habits of cleanliness.
6. Lack of will power and low mentality.
7. Perfect habits of mastication.
8. Abundance of food in the dietary requiring adequate mastication.
9. Normal, freely-flowing salivary secretion, nature's flushing agent.
10. Regularly aligned arches.
11. Youth and old age, these conditions frequently not admitting of extensive operations.

Cavity margins may frequently be placed in immune areas by separating the teeth and building fillings out to full contour, thus drawing labial, buccal and lingual margins away from each other. This procedure often obviates the necessity for extensive cutting of tooth structure.

Drawings

Draw the typical outline form of the following cavities.

1. Fissure cavity on the occlusal surface of 4 or 5 running full length of the occlusal groove (Fig. 126).
2. Pit and fissure cavity on the occlusal surface of 4 and 5, occupying the mesial and distal pit in 4 and running full length of the groove in 5 (Figs. 127 and 128). In 5 there are

two typical forms depending on the shape of the occlusal groove.

3. Cavity in central and distal fossæ of 6, 7 and 8 (Figs. 129 and 130). If the oblique ridge is left very weak, unite the cavities. If 8 has three cusps, the typical form will appear as in Fig. 131.

4. Cavity on the occlusal surface of 6 (Fig. 132).

5. Cavity on the occlusal surface of 7 (Fig. 133). On 8 the outline form will appear like that for 6, or 7, depending on the form of the tooth.

6. Mesial cavity on 1 (Fig. 131). The outline form for proximal cavities in the six anterior teeth, upper or lower, is about the same.

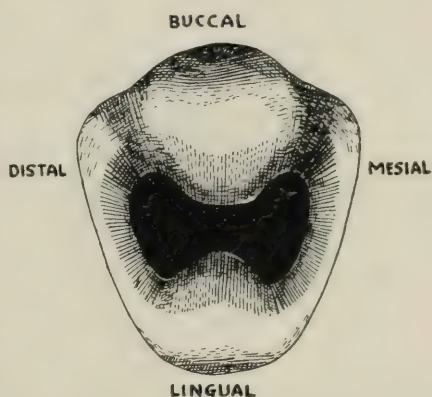


FIG. 126.—Outline form. Occlusal cavity on the upper first bicuspid.

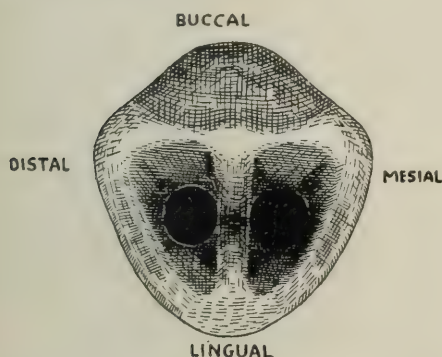


FIG. 127.—Outline form. Occlusal cavities on the lower first bicuspid.

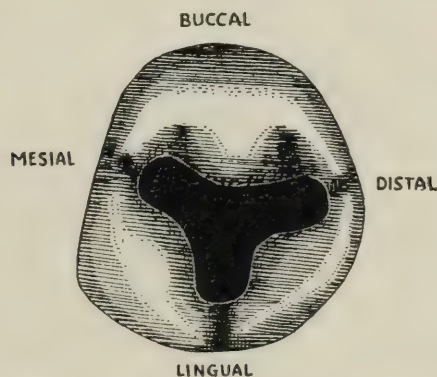


FIG. 128.—Outline form. Occlusal cavity in a lower second bicuspid with three cusps.

Technic for Establishing the Outline Form.

(1) *On Enlarged Plaster Teeth.*—(a) With a pencil draw the outline form. (b) With vulcanite chisels and scrapers remove enough of the plaster to establish a definite cavity.

(2) *On the Technic Block.*—(a) With a pencil draw the outline form. (b) With chisels and excavators remove enough of the tooth substance to establish a definite cavity.

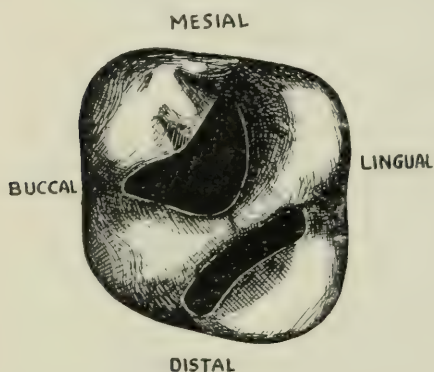


FIG. 129.—Outline form. Occlusal cavities in upper molar.

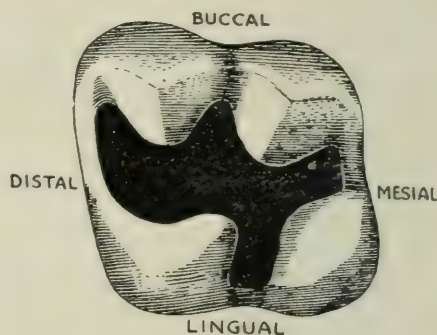


FIG. 130.—Outline form. Occlusal cavity in upper molar involving central and distal fossæ and lingual groove.

(3) *On Extracted Teeth.*—(a) With a pencil draw the outline form. (b) With the chisel cut away the overhanging and unsupported enamel. (c) If necessary to extend further, first remove the underlying dentin with excavators (hoes,

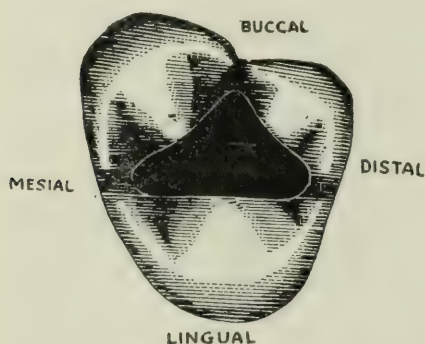


FIG. 131.—Outline form. Occlusal cavity in an upper third molar with three cusps.

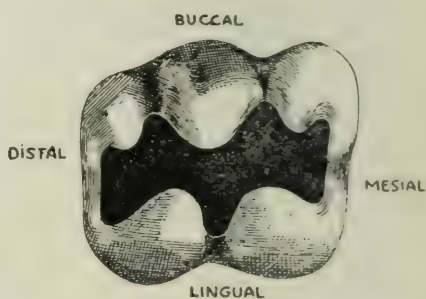


FIG. 132.—Outline form. Occlusal cavity in the lower first molar.

hatchets and spoons) and then chisel the enamel the desired distance.

The **Technic** for obtaining outline form when operating in the mouth is herewith given.

1. *Pit and Fissure Cavities*.—If small, open and extend full length of the fissure with a dentate fissure bur. In using, extend the point of the bur under the enamel and cut from within, outward. Small pits may frequently be better opened at the beginning with the round bur. If necessary to extend the margins much, an inverted cone bur will first undermine the underlying dentin, when the enamel may then be readily removed with the straight or bin-angle chisel, by means of hand pressure or the mallet. In large cavities of this class, first chisel away overhanging enamel margins,

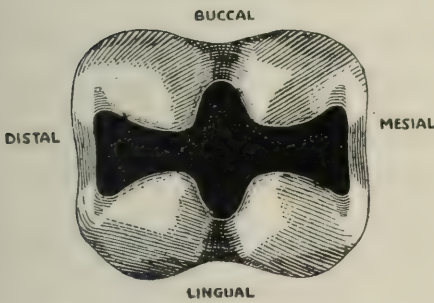


FIG. 133.—Outline form. Occlusal cavity on lower second molar.



FIG. 134.—Outline form. Mesial cavity in the upper central incisor.

then use the inverted cone bur for extension into solid dentin, after which use the chisel again for removal of any further enamel.

2. *Smooth Surface Cavities*.—First break down all unsupported enamel with the chisel, cutting in the direction of the length of the enamel rods. Avoid shock by refraining from cutting too large amounts at each thrust or blow. Then, if necessary to extend margins further, first, undermine the underlying dentin with the inverted cone bur, when the enamel may then be readily removed by means of the straight or bin-angle chisel, Black's side-cutting instruments or gini-

val margin trimmers, depending on the location. Hatchet and hoe excavators are also of value for cutting dentin.

2. Remove the Decay.—Complete removal of decay is essential. If the minutest portion be left unsterilized, decay will continue, producing irritation of the pulp via the dentinal fibrillæ, and finally result in the undermining of the filling. Although during the performance of the first step, viz.: establishment of the outline form, much of the carious matter will be removed, it should be done, not with that idea primarily in view, as is so frequently the case with inexperienced operators, but it should be merely incidental to the operation of placing the cavity margins in their proper location.

During the progress of caries, decalcification by lactic acid precedes invasion by micro-organisms. This being the case, the deepest portion of the dentin may have been "*affected*" to some extent, though not necessarily decayed and "*infected*." Discoloration also frequently precedes the process of decay. Therefore, the dentist is in some instances justified in leaving portions of discolored or partially *affected* dentin on the walls of cavities to avoid possible exposure of the pulp. In such cases the cavity should be thoroughly sterilized. However, in every instance it is necessary to remove the smallest trace of infected and decayed dentin to prevent the continuance of decay under the filling and to avoid irritation and inflammation of the pulp.

The *method of removal of decay* depends on the character of the tissue, the size and location of the cavity and the sensitivity of the dentin.

1. Shallow Cavities on Exposed Surfaces.—The dentin is usually very sensitive in these cavities. Remove it with hatchet or hoe excavator, or the round bur. Do not temporize, but make decisive cuts, removing the decayed matter as quickly and in as large bulk as possible.

2. *In Large Cavities with Soft Decay.*—Use spoon excavators, first flaking up the decay around the margins and then peeling it off in layers, avoiding pressure.

3. *Hard, Dark-brown and Black Decay.*—Use spoon excavators. The round bur may also be utilized, but never in close proximity to the pulp.

3. **Give the Cavity Form.**—(a) **Convenience Form.** By convenience form is meant the shaping of the cavity in such a manner that it may be most conveniently seen and approached with instruments. If the cavity be of difficult access, owing to its location, the slight extension of a margin is frequently admissible for this purpose. The extension of the labial margins of proximal cavities for convenience is not admissible, as this would result in too great a display of filling material. In every instance where it becomes necessary to extend margins for convenience form, the extension is made at the expense of the *lingual* margin, the filling being packed in that case largely from the lingual side. *The display of extensive gold operations in the front teeth is an offence against the esthetic sensibilities of all refined individuals, and a sure sign of a depraved taste on the part of both patient and operator.*

For convenience in starting gold, the **point angles** to be described under “retention form” are frequently deepened, or made more acute, this procedure, then, being really a convenience form (see Fig. 168).

(b) **Resistance Form.**—The so shaping of the walls of the cavity that they may be best enabled to withstand the **stress** brought to bear on the filling during the act of mastication. In mechanics, the general form of a cavity which is to receive an inlay is the box or **simple mortise**. This general idea is applied in preparing cavities in teeth. In this form, all of the walls of the **mortise** are on plain or straight lines, joining each other at definite line and point angles.

Technical Exercises

On six cubes of plaster of Paris 2 inches square, prepare the six forms of mortise. Study the line and point angles in these imaginary cavities.

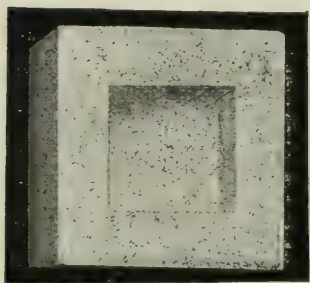


FIG. 135.

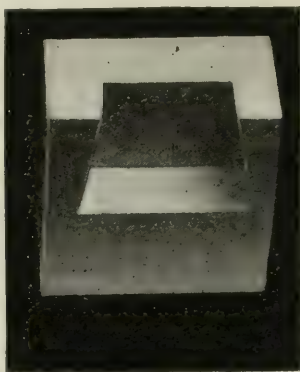


FIG. 136.

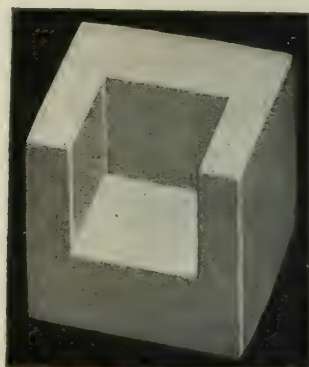


FIG. 137.

FIG. 135.—Simple mortise on one surface.

FIG. 136.—Simple dovetail mortise on one surface. The plaster block has been sawed in half to show the inside of the cavity, which is dovetailed on two opposite surfaces.

FIG. 137.—Simple mortise form involving two surfaces.

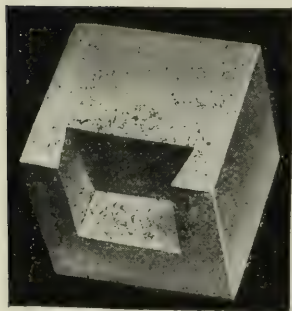


FIG. 138.

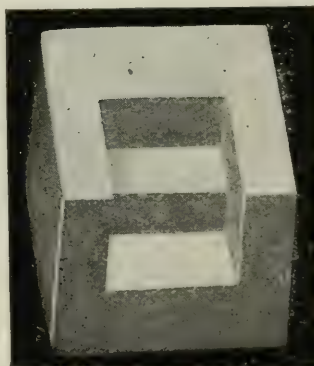


FIG. 139.

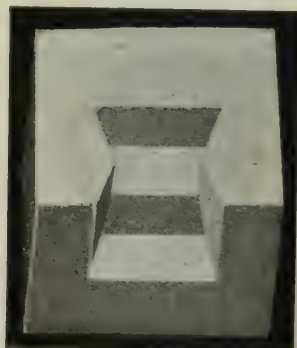


FIG. 140.

FIG. 138.—Method of dovetailing the simple mortise involving two surfaces, thus making it retentive in form.

FIG. 139.—Auxiliary mortise (step form).

FIG. 140.—Compound dovetail mortise.

Rules for obtaining resistance form.

Rule 1.—In the shaping of all simple cavities, use the simple mortise form, or some modification of it. Examples

illustrating the application of the simple mortise to cavity formation are seen in Figs. 141, 142, 143 and 144.



FIG. 141.

FIG. 141.—Cavity in the central fossa of a right upper first molar tooth.

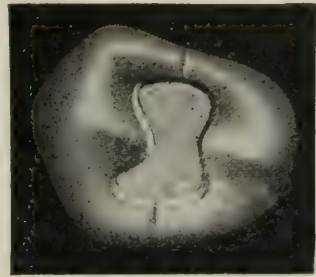


FIG. 142.

FIG. 142.—Cavity involving the occlusal groove on an upper bicuspid.

Rule 2.—In proximo-occlusal cavities on bicuspid and molars, where the strength of buccal and lingual walls will

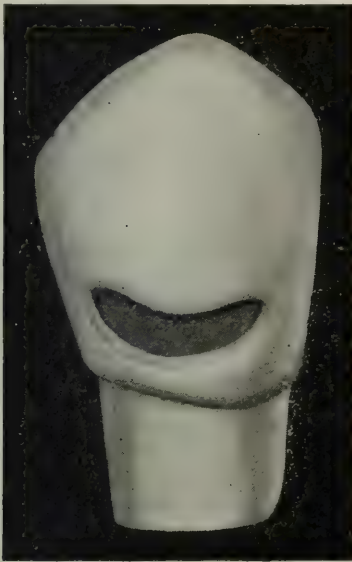


FIG. 143.

FIG. 143.—Cavity in the gingival third of the labial surface of a cuspid.

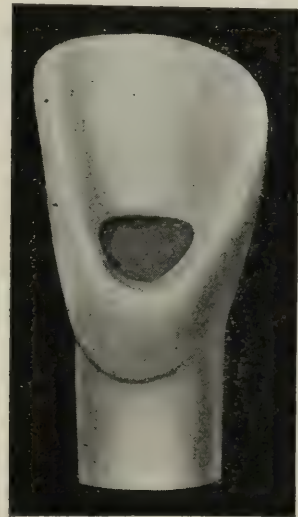


FIG. 144.

FIG. 144.—Cavity involving the lingual pit of a left upper lateral incisor.

permit and there is no decay on the occlusal surface, use the **simple mortise form involving two surfaces** (see Figs. 145 and 146).

Rule 3.—In proximo-occlusal cavities in other cases than the above, use the **double, compound or auxiliary mortise form** (step form) (Fig. 149, 150 and 151).



FIG. 145.



FIG. 146.

FIG. 145.—Application of the simple dovetail mortise form to a disto-occlusal cavity in an upper molar, where the occlusal surface presents good union of enamel plates and is free from decay.

FIG. 146.—Cavity similar to that shown in Fig. 145.



FIG. 147.



FIG. 148.

FIG. 147.—Application of the compound mortise form to a mesio-occlusal cavity on an upper bicuspid.

FIG. 148.—Another view of the cavity shown in Fig. 147.

Rule 4.—In proximo-incisal cavities, where the loss of the mesio- or disto-incisal angle is not extensive and where the

stress of mastication is not great, use the **simple mortise form**. (Figs. 154, 155, 156 and 157.)

Rule 5.—In proximo-incisal cavities, when the involvement of the incisal edge is extensive, use the **double, compound or**



FIG. 149.

FIG. 149.—Step form in a mesio-occlusal cavity on an upper molar.

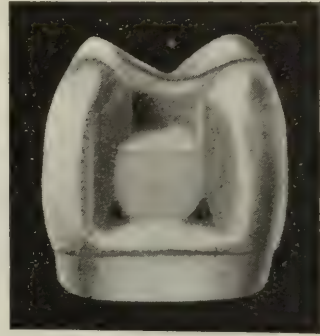


FIG. 150.

FIG. 150.—Proximo-occlusal cavity on an upper molar. The step form.



FIG. 151.

FIG. 151.—Proximo-occlusal cavity involving the mesial and distal fossæ on an upper molar.

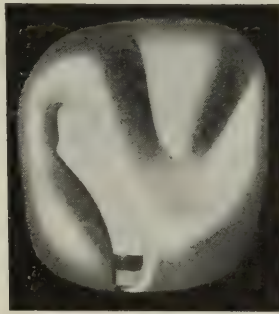


FIG. 152.

FIG. 152.—Cavity running full length of the lingual groove on an upper molar.

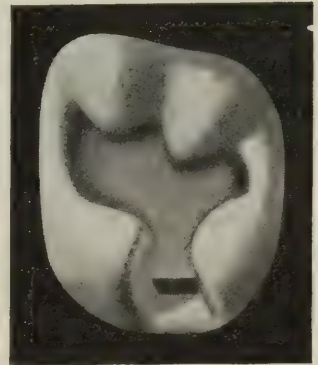


FIG. 153.

FIG. 153.—Cavity involving the central and distal fossæ and lingual groove on an upper molar.

auxiliary mortise form, either in the shape of an incisal step or a lingual step form (see Figs. 158, 159, 160 and 161).
Technic for Obtaining Resistance Form.

Use inverted cone burs, hatchet and hoe excavators and straight-edged chisels. All of these cut plane surfaces,

joining at definite angles, and give the box or mortise form.

1. **Pit and Fissure and "Gingival Third" Cavities.**—With the burs, excavators and chisels **flatten** the pulpal or axial wall of the cavity, and true up the lateral walls until they are **plane surfaces**, parallel with each other and joining with the pulpal or axial wall (the seat) at **definite angles** (see Figs. 141, 142, 143 and 144).



FIG. 154.



FIG. 155.



FIG. 156.

FIG. 154.—Mesial cavity on an upper central incisor showing the flat gingival wall.

FIG. 155.—Lingual view of the same cavity shown in Fig. 154.

FIG. 156.—Cavity shown in Figs. 154 and 155 seen from a different aspect. The triangular form with three point angles is noticeable.

2. **Cavities in the Proximal Surfaces of the Incisors and Cuspids not Involving the Angle.**—(a) With inverted cone burs, hatchets, hoes and chisels, flatten the gingival and axial walls, making a definite **line angle** at their junction. (b) Bring the axial, gingival, labial and lingual walls together at two definite **point angles** (labio-gingivo-axial and lingo-gingivo-axial point angles). (c) Join the labial and lingual walls together at a definite **point angle** at the incisal portion of the cavity, the resultant form being triangular in shape, with three definite point angles (Figs. 154, 155 and 156).

3. **Cavities in Proximal Surfaces of Incisors and Cuspids Involving the Angle.**—(a) If the simple mortise form is adopted the procedure is practically the same as that described in the preceding paragraph, consisting in **flattening** the gingival and axial walls and joining them at a definite **line angle**, the gingivo-axial line angle. The resistance form is afforded by the flat gingival wall.



FIG. 157.



FIG. 158.



FIG. 159.

FIG. 157.—Cavity on the proximal surface of a central incisor. The simple mortise form.

FIG. 158.—Mesio-incisal cavity on an upper central incisor. Labial view. An effort has been made to preserve as much of the labial enamel plate as conditions will permit.

FIG. 159.—Lingual view of the cavity shown in Fig. 158. The flat gingival wall is well shown; also the cutting of the incisal step more at the expense of the lingual wall in order to preserve the labial enamel plate.

(b) *Incisal Step Form.*—With a carborundum stone remove the cutting edge over into the middle lobe of the tooth, until the dentin is exposed. The labial and lingual margins of the cavity should first have been extended out in close proximity to the mesial or distal groove (depending on whether the cavity is mesial or distal) and the angle cut away the same distance. Now, with the inverted cone bur, cut a

groove across the cutting edge, in between the labial and lingual enamel plates, into the dentin, which has been exposed by the carborundum stone. Then remove a portion of the lingual enamel plate, leaving the labial plate untouched as far as possible, to avoid exposure of gold, and then deepen the groove further, continuing in this manner until the step is of sufficient size to admit of the necessary strength for



FIG. 160.



FIG. 161.

FIG. 160.—Lingual step form in an upper lateral incisor. The gingival wall, instead of being made flat, has been cut to follow the curvature of the gingival line somewhat, in order to provide a better seat and anchorage for the filling.

FIG. 161.—Labial view of the mesio-incisal cavity with lingual dovetail, shown in Fig. 160.

resistance and to allow of a sufficient body of gold to withstand all strain (see Figs. 158, 159, 164, 165, 166 and 167).

(c) *Lingual Step Form*.—This form is used where the tooth is too thin labio-lingually to warrant the incisal step. With an inverted cone bur cut an auxiliary mortise form or step on the lingual surface of the tooth. The floor of this step is made flat and the lateral walls plane surfaces, joining the floor

at definite line angles. Avoid exposing the pulp (see Figs. 160 and 161).

4. Cavities in Proximal Surfaces of Bicuspids and Molars.

—As a general rule, the cavity is extended onto the occlusal surface in the form of a step, it frequently being necessary to break down the marginal ridge. There are three methods of accomplishing this:



FIG. 162.

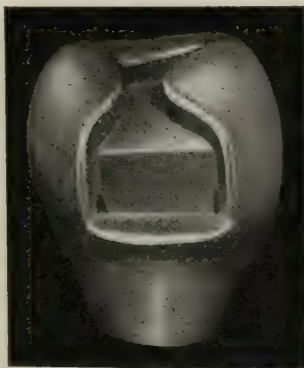


FIG. 163.

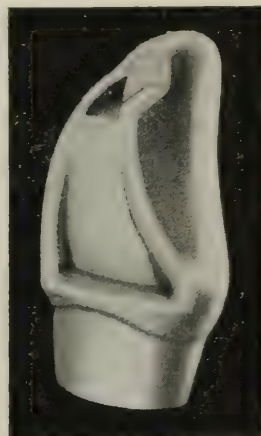


FIG. 164.

FIG. 162.—Proximo-occlusal cavity in an upper bicuspid. Step form.

FIG. 163.—Proximo-occlusal cavity on a bicuspid. Compound mortise or step form.

FIG. 164.—Proximo-incisal cavity on a central incisor. It has been necessary to involve both labial and lingual enamel plates owing to thinness of the tooth in the incisal region.

First Method.—With a chisel and mallet cut a V-shaped opening through the marginal ridge, enlarging it until free access to the cavity is gained.

Second Method.—With a bi-bevelled drill inserted into the occlusal pit or fossa, drill an opening through the dentin toward the proximal cavity until the area of decay is reached. Then cleave away the enamel of the marginal ridge as before, by means of the chisel, or remove it with a dentate fissure bur.

Third Method.—Adjust the separator and attack the

enamel from the buccal side with a chisel, gradually shifting more and more to the occlusal and continuing until the ridge is sufficiently removed.

After removal of the marginal ridge, extend the cavity in the form of a step, by means of the fissure and inverted cone burs and hatchet excavators, the full length of the occlusal groove (bicuspid), or to include the entire central



FIG. 165.

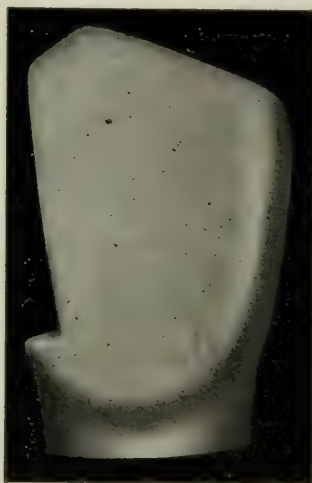


FIG. 166.



FIG. 167.

FIG. 165.—Step form in a disto-incisal cavity on an upper cuspid.

FIG. 166.—Labial view of a mesio-incisal cavity on an upper cuspid showing flat gingival wall.

FIG. 167.—The incisal step form applied to a distal cavity on an upper cuspid. The labial enamel has been preserved.

fossa (molars). With inverted cone burs, hoes and side cutting instruments, flatten the gingival wall (the seat), make the buccal and lingual walls parallel with each other and joining the gingival wall at right angles. Make a definite line angle at the junction of the gingival and axial walls (gingivo-axial) and definite point angles (bucco-gingivo-axial and linguo-gingivo-axial) at the buccal and lingual terminations of this line. Flatten the top of the step, the pulpal wall, and cut that portion of the cavity, as well as the proxi-

mal part, to the box form with its line and point angles (see Figs. 148, 149, 150, 151, 162 and 163).

Seat.—In simple cavities the bottom or floor of the cavity, either the axial or pulpal wall.

Step.—The auxiliary portion of the compound mortise form, consisting of the axial and pulpal walls in complex cavities.

(c) **Retention Form.**—The so shaping of the cavity that the filling may be enabled to resist **tipping or lifting stress**.

(1) *In pit and fissure and gingival third cavities*, where the *depth* of the cavity is greater than its *diameter*, no extra retention form is needed, the filling being retained by its contact with the lateral walls of the cavity. The accomplishment of this condition, though, is not often admissible, owing to the proximity of the pulp. In the majority of cases, then, retention is provided for by transforming the simple mortise form into the dovetail mortise form (Fig. 136). In doing this, one, or at most two, opposite walls of the cavity are **slightly dovetailed**. (2) *In proximal cavities on incisors and cuspids not involving the angle*, retention is provided for by **making more acute** the labio-gingivo-axial, lingo-gingivo-axial and the incisal **point angles** (Figs. 154 and 156). (3) *In proximal cavities on incisors and cuspids involving the angle*, the gingival and incisal point angles are deepened as in “(2),” for the **simpler cases**. In the **incisal step** form, the entire step, which has been given a flat floor, is **dovetailed** on its labial and lingual walls, and slightly deepened at its extremity (Figs. 159 and 164). In the **lingual step** form the step is **dovetailed** throughout, and its two point angles rendered more acute (Fig. 160). (4) *In proximo-occlusal cavities on bicuspid and molars* the gingival **point angles** are rendered more acute in both the simple mortise form and the compound mortise form (Figs. 145, 162 and 163). The

simple mortise form is now transformed into the **dovetail mortise form** by cutting at the expense of the buccal and lingual walls, rendering the cavity wider, bucco-lingually at the junction of the buccal and lingual walls with the axial wall (Fig. 145). In the **compound mortise form**, after accentuating the gingival point angles, dovetail the lateral walls of the **auxiliary portion** (the step), and slightly deepen

the two point angles in that portion (Figs. 147, 148 and 163).

Technic for Retention Form.

Use the inverted cone bur, chisel, hatchet and hoe. In deepening the gingival point angles, do so more at the expense of the **axial, labial, buccal and lingual walls**, than of the gingival wall. Place the blade of the instrument in the point angle, and after slightly deepening it at the expense of the gingival wall, cut along the line angle uniting the labial, buccal or lingual wall (as the case may be) with the axial wall, for a distance of about

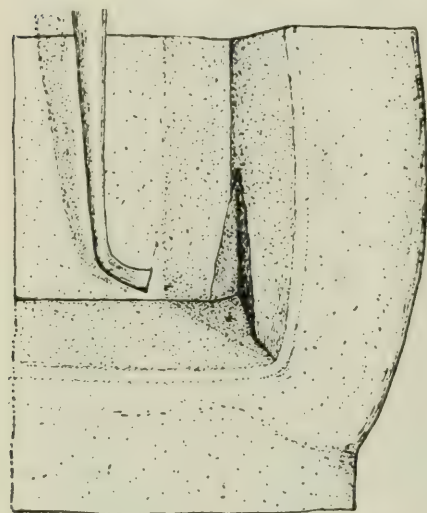


FIG. 168.—Accentuating the gingival point angle for convenience and retention form. In most instances an inverted cone bur number one-half or number one is used.

one-fourth the length of the wall, thus forming a slight groove, which gradually disappears at its termination (Fig. 168). For making the incisal retention form in proximal cavities in incisors and cuspids, use the *acute angle hatchet*, placing its blade in the point angle and cutting at the expense of the **labial and lingual walls**, as well as deepening the angle toward the **incisal**.

4. **Bevel and Polish Enamel Margins.**—What has been said about resistance and retention forms applies entirely to the dentin, these forms being provided for at the expense of

that material. The enamel is an extremely **brittle** substance, owing to its chemical composition (being composed largely of inorganic salts) and its histological structure. **Microscopically**, it consists of numerous layers of hexagonal shaped rods, united together with cementing substance. Each individual rod is composed of prisms placed end to end, each of these also united (much more firmly than the rods) with cement substance. **Mechanically**, the material resembles a

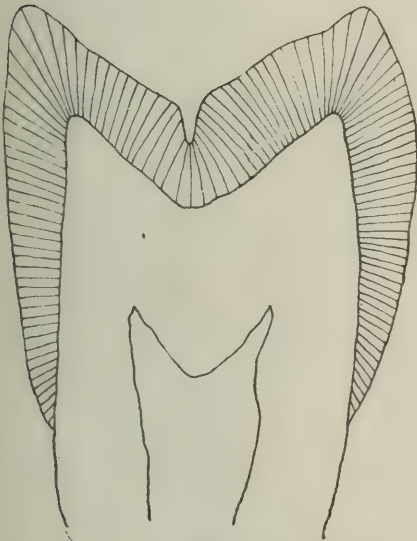


FIG. 169.—Diagram showing the direction of the enamel rods on a bicuspid. Mesial view.

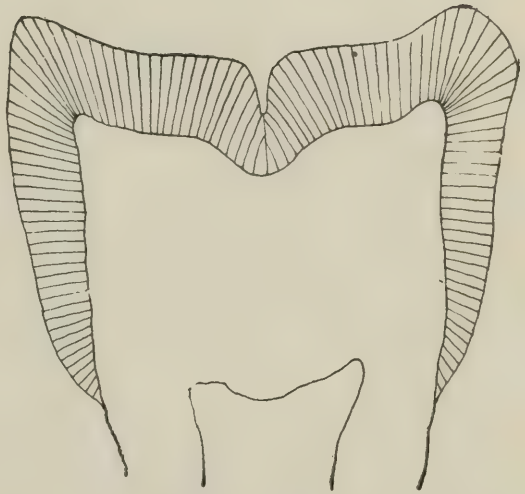


FIG. 170.—Radiation of the enamel rods on a molar. Mesial view. (Diagrammatic.)

brick wall, the prisms representing the individual bricks and the rods representing a single layer of them, the layers being superimposed one upon the other. The difference, though, between the enamel and the brick wall is that in the wall the various layers run parallel to the surface on which they are placed, while in the enamel they run perpendicular to the dentin, radiating around in various directions, depending on the surface from which they are viewed, *one end of the rod lying on the dentin, the other being at the surface.*

If the underlying dentin be first undermined by decay or through the action of cutting instruments, these rods may be easily **chipped away in layers** in the direction of their length by means of chisels. Owing to the fact that they run in various directions, depending on location, it is necessary that a brief study of them be here made, in order that we may intelligently and expeditiously **chisel** them away.

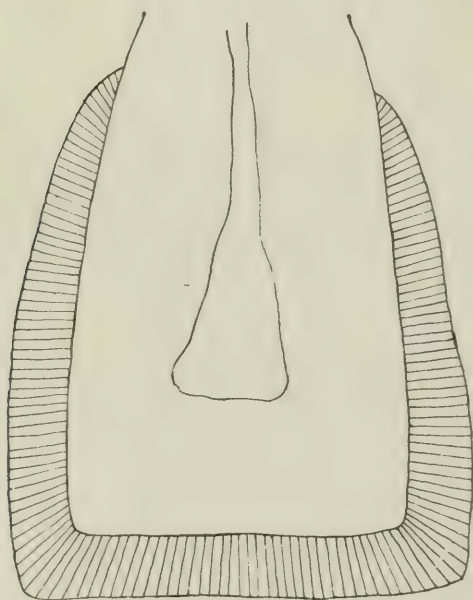


FIG. 171.—Radiation of enamel rods on an incisor. Labial view. (Diagrammatic.)

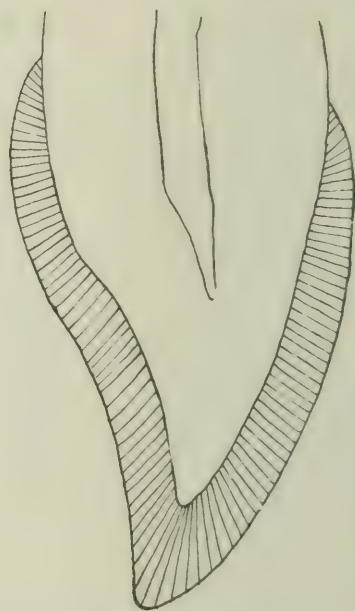


FIG. 172.—Proximal view of a central incisor showing radiation of enamel rods. (Diagrammatic.)

Rule.—On plane surfaces the enamel rods are placed **perpendicular** to the dentin; on concave surfaces they radiate toward each other, while on convex surfaces they radiate away from each other.

By referring to the illustrations (Figs. 169 and 170), it will be seen (1) that their outer ends approach each other at pits and fissures in **bicuspid**s and **molars**: (2) that they radiate more and more to the perpendicular, as the points of the cusps are reached; (3) then, as we go over to the

axial surfaces, they begin to run more and more horizontally to the long axis of the tooth; and (4), as the cervical line is approached, their outer ends begin to radiate toward the cervical, following the general law already mentioned, *viz.*, that they run perpendicular to the surface of the dentin.

Practically the same conditions exist in the **centrals, laterals and cuspids**, the same general laws being applicable (Figs. 171 and 172). (1) On incisal surfaces the rods are perpendicular to the long axis of the tooth; (2) at the angles the rods on the incisal and axial surfaces approach each other; (3) while on axial surfaces they lie more or less horizontal to the long axis of the tooth; (4) radiating gingivally as the cervix is approached.

In the manipulations incident to the fourth step of cavity preparation, the established law is to **bevel** the enamel margins outward, following the direction of the rods in the location in which we are working. The dentin is the natural support of the enamel. A study of the accompanying illustrations will demonstrate why bevel of these margins is necessary in order that no rods be left unsupported, the amount of bevel depending on the direction of the rods. In **pit and fissure** cavities very little bevel is necessary, the amount being increased with the increase in size of the cavity, and the approach of its margins toward the points of the cusps. In **proximal** cavities a marked bevel is indicated at the gingival margin (see illustration), while the amount on the incisal margins will depend on their proximity to the angle and the convexity of the surface, the rods deviating more at the angles and on distal convex surfaces.

In **centigrades** the amount of bevel for cavity margins will usually range between 2 and 7 degrees, depending on location and the filling material to be used. *The tendency of beginners will be to bevel too much.*

Technic for Beveling and Polishing Enamel Margins.

Chisels of razor-like sharpness are the instruments indicated in the majority of cases. The bevel should always be a definite one, and on *straight* lines, not curved. If the chisel is of proper sharpness, the margins may be sufficiently smoothed and polished. *When two margins join each other at an angle, the angle should be slightly rounded, being careful to leave the definite line angle in the underlying dentin.* For gingival margins, Black's gingival trimmers are constructed so as to give the proper bevel. These may also be used on buccal, labial and lingual margins, or else the Black enamel hatchets.

Technic.—Bevel with chisels the margins of the cavities in the plaster cubes illustrating the various mortise forms; also those prepared in the plaster and extracted teeth, as well as on the technic block.

5. **Perform the Toilet of the Cavity.**—The manipulations incident to performance of the toilet of the cavity may be outlined as follows:

1. Remove all debris with the chip blower and warm air.
2. Inspect the cavity for any remaining decay, which should be removed, if found.
3. Swab the walls throughout with dry cotton or spunk, thus loosening any further debris; then use the air syringe again, thoroughly drying the walls.
4. If sterilizing agents are, or have been used, swab the walls with alcohol, evaporate and dry again with cotton, and then freshen up the surfaces with a sterile bur before filling.
5. If, after completion of the cavity preparation, a dressing is sealed in until the next sitting, freshen up the walls with a sterile bur again before insertion of the filling.
6. All fillings should be placed against clean, freshly cut walls.

Technical Exercises

1. **Preparing Cavities in the Bone Handle.**—This handle may be obtained from the Wenker Dental Mfg. Co., or the S. S. White Dental Mfg. Co. (Figs. 173, 174).



FIG. 173.—Bone handle.

Prepare with hatchets, hoes and chisels the six cavities indicated in the illustration; numbers 1, 2 and 3 on the broad side of the handle and number 5 on the narrow side, repre-



FIG. 174.—Bone handle.

senting the ordinary form of pit and fissure and gingival third cavities; number 6, a proximal cavity on an incisor; number 4 on the flat end, being similar in shape to the step form in molars.

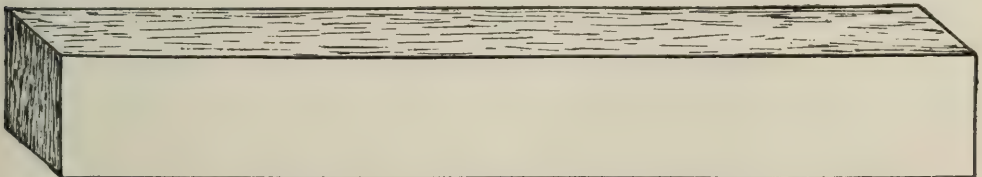


FIG. 175.—Celluloid handle or block for cavity preparation exercises.

2. **Preparing cavities in the enlarged plaster teeth,** carved in the Dental Anatomy Technic Course.

Prepare several typical form pit and fissure and smooth

surface cavities. The cuttings are to be made with vulcanite chisels and scrapers, after drawing the outline form with pencil. Deepen the convenience angles with hatchet and hoe excavators and chisels.

3. **Preparing cavities in the ivory teeth** carved in the Dental Anatomy Technic Course. Typical cavity forms are made with the chisels, hatchets and hoes.

4. **Preparing Cavities in Extracted Teeth.**—First, soak the teeth in glycerin one part and water two parts, to render them less brittle. Select teeth with cavities of decay and prepare typical cavities, with the same instruments as indicated above. Avoid exposure of the pulp, and, in chiselling enamel, cut in the direction of the rods, finally bevelling in the various locations to avoid leaving any unsupported rods.

5. **Preparing Cavities in the Typodont or Odontotype.**—Practice the proper rests and guards.

CHAPTER VI

FILLING MATERIALS

Filling.—A material so placed in the prepared cavity of a tooth that the physiological and mechanical functions of the organ, its anatomical form, occlusion, contact point and esthetic appearance are properly restored or preserved, and the cavity itself protected as far as possible from future decay.

Attributes of an Ideal Filling Material.

1. Insolubility,
2. Harmonious color,
3. Adaptability to cavity walls,
4. Crushing resistance,
5. Freedom from molecular change,
6. Non-conductivity,
7. Capability of polish,
8. Convenience of manipulation.

1. **Insolubility.**—The mouth frequently contains, in addition to the watery constituents of the saliva, chemical substances, such as **acids**, which have a tendency to unite with and dissolve certain metals or their salts, as well as tooth structure; hence the necessity for the selection of a filling material which will resist the action, not only of water, but also of these chemicals.

2. **Harmonious Color.**—People of refinement and culture demand the use of a filling material which, where exposed to view, is harmonious in color, or at least presents a pleasing contrast to natural tooth structure, being as slightly con-

spicuous as possible. Those individuals who do not possess this attribute of correct appreciation of the **esthetic** should be educated in that direction by a high sense of the artistic displayed on the part of the **ethical** dentist.

3. **Adaptability to Cavity Walls.**—For filling teeth, materials should be selected which can be most perfectly adapted to the walls of the cavity and maintain that adaptation, in order that the cavity may be perfectly and permanently **sealed** against the entrance of moisture.

4. **Crushing Resistance.**—During the act of mastication, the teeth are subjected to a crushing **stress** ranging from 75 to 250 pounds pressure, depending on the object incised or chewed, the teeth performing the work and the strength of the muscles of mastication. This being the case, the filling must possess the necessary resistance to strain and wear as well as **density, hardness, and tenacity**, to withstand this stress. The greater amount of the latter qualities it contains, the more "*edge strength*" it possesses when built out over long enamel bevels.

5. **Freedom from Molecular Change.**—All matter is composed of **atoms** united together in definite proportions to form **molecules**. These molecules possess certain characteristics, and have certain definite relationships to each other, as far as their shape, size, closeness of adaptation and position is concerned. In some metals, the molecules of which they are composed have a much greater tendency to change their relationship than others under certain physical conditions, such as **constant pressure, age, heat and cold**. Filling materials, under the conditions to which they are subjected in the mouth, should be especially free from this tendency to molecular change.

6. **Non-conductivity.**—The dentinal fibrillæ, when their ends are exposed, through loss of the enamel covering, conduct

to an exalted degree sensations of **heat, cold** and **electricity**, when present in the mouth, to the pulp. The pulp rebels on reception of these sensations, responding in the form of a **paroxysm of pain**. This being the case, the ideal filling material should be a non-conductor, so that when placed, these sensations may not be transmitted through its substance.

7. **Capability of Polish**.—The highly polished condition of the enamel prevents, to quite an extent, the **accumulation of food** on its surface. Filling materials should be capable of taking a high degree of polish for the same reason.

8. **Convenience of Manipulation**.—Filling materials should be easily and conveniently manipulated, so that the operation may be completed **quickly**, and with as little **strain** as possible on patient and operator.

Classification of Filling Materials

The materials to be considered are Gold, Amalgam, Cement, Tin, Gutta-percha. None of these fill all of the above requirements, hence the ideal filling material has not yet been discovered. Gold, Amalgam and Tin may be considered as **Permanent** filling materials, as they have sufficient lasting qualities to be classed in that category, while Cement and Gutta-percha, owing to their short period of usefulness, are classed as **Temporary** filling materials. Another classification of filling materials is into **Plastic** and **Non-plastic**. The **Plastics** include Amalgam, Cement and Gutta-percha, these materials being worked while in a soft or plastic state, and hardening after being placed in position; the **Non-plastics** including Gold and Tin, which do not possess this quality.

PLASTIC FILLING MATERIALS

Gutta-percha—Cement—Amalgam

GUTTA-PERCHA

Origin.—The purified concrete juice obtained by tapping the Isonandra Gutta, an evergreen tree found principally in the Malay Peninsula and Archipelago.

Characteristics.—Color, almost white, or rose, or grayish white. Inodorous. Slightly elastic. It contracts on hardening or cooling. It is very bland and unirritating to the soft tissues, and is an absolute *non-conductor*. It in time becomes porous and disintegrates in unclean mouths. Freely soluble in chloroform, while oil of eucalyptus, eucalyptol and oil of cajeput have a softening effect on it. Heat softens it, but it hardens again on cooling.

Varieties of Dental Gutta-percha.—Gutta-percha is not used in dentistry in its pure state, but is combined with other materials to give it desirable working qualities. Of these, the principal ones are white wax, zinc oxid, or calcium oxid. Gutta-percha for dental use may be **classified** under one of the following headings:

1. Low heat—softens below 200° F. (1 part Gutta-percha, 4 parts Zinc Oxid).
2. Medium heat—softens from 200° to 212° F. (1 part Gutta-percha, 6 or 7 parts Zinc Oxid).
3. High heat—softens from 210° to 225° F. (Zinc Oxid to saturation).

There are a number of **varieties** of Gutta-percha in use for dental purposes, among which are the following:

1. Excelsior Gutta-percha—high heat—(softens at 225° F.).
2. Premium Gutta-percha—medium heat—(softens at 208° F.).

3. Superior Gutta-percha Stopping—high heat.

4. Flagg's Gutta-percha Stopping { Medium Heat,
High Heat,
Low Heat.

5. White Base Plate Gutta-percha—medium heat.

6. Pink Base Plate Gutta-percha—medium heat.

7. Hill's Stopping.

Formula:
(Herman Prinz) { Feldspar 1 part,
Quartz 1 part,
Quicklime 2 parts,
Gutta-percha base plate q.s. to make
a stiff paste.

8. Temporary Stopping—(dressing seal)—low heat.

Formula: { White or Pink Base Plate $\frac{1}{4}$ parts,
Zinc Oxid 4 parts,
White Wax 1 part.

Used for sealing temporary dressings.

9. Gutta-percha Points for Filling Canals.

Advantages of Gutta-percha.

1. Non-conductivity.
2. Ease of introduction.
3. Harmonious color (the white varieties).
4. Elasticity—(an advantage in making slow separation).

Disadvantages.

1. Low Crushing resistance. It cannot be used as a permanent filling material on surfaces exposed to mastication.
2. Subject to chemical action of lactic acid and sulfids in unclean mouths, readily disintegrating.
3. Shrinkage on cooling, with consequent tendency to draw from cavity walls.
4. Incapability of polish.

Uses.

1. As a temporary filling material in deciduous teeth.
2. As a more or less temporary filling material in unexposed cavities in permanent teeth.
3. For sealing in dressings.
4. For producing slow separation.
5. For filling root canals.
6. For temporarily setting crowns and bridges.
7. As a cavity lining and for filling small canals in the form of chloro-percha.

Chloro-percha is made by dissolving shavings of base plate gutta-percha in chloroform. On the evaporation of the chloroform the gutta-percha is left on the cavity wall or in the canal.

Method of Manipulation.—Give the cavity retentive form. Before insertion, the walls may be slightly moistened with eucalyptol, oil of eucalyptus, or oil of cajuput, preferably the first agent mentioned. Avoid overheating the gutta-percha, as the product is thus easily injured. Heating may be accomplished over the alcohol lamp, Bunsen burner, Flagg's Gutta-percha heater (Figs. 176 and 177), the thermoscopic heater, or on an electric annealer; then follow one of the following **methods**.

1. Cut the Gutta-percha into small pieces, soften with heat and pack each piece separately, condensing thoroughly with *cold* burnishers of suitable size. Avoid much excess, as the material is rather difficult to remove. Remove surplus material immediately with a *hot* flat spatula, trimming toward the margins. Smooth the surface of the filling with the same instrument, *slightly warmed*. If preferred, the filling may be allowed to cool and harden thoroughly, when the excess is removed with a *sharp* knife blade, but the knife must be very keen to avoid drawing the filling away from the margins.

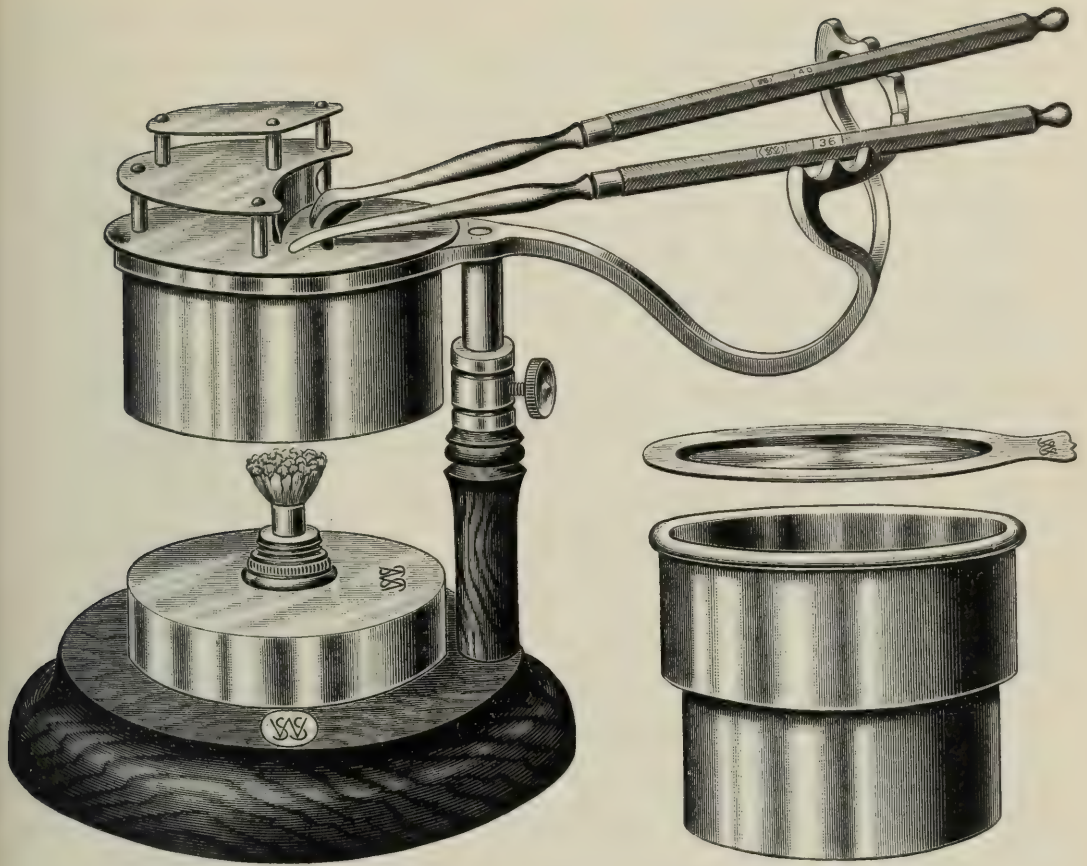


FIG. 176.—Flagg's gutta-percha and tool heater.

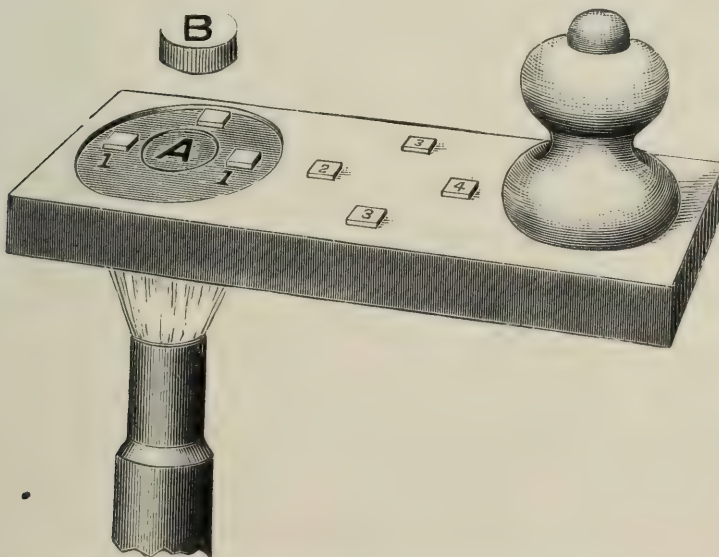


FIG. 177.—Thermoscopic heater for gutta-percha.

2. In cavities of easy access, heat the Gutta-percha and, while soft, mold into a mass of sufficient size to fill the cavity, packing with a *warm* burnisher, condensing thoroughly against the walls, and trimming the excess after either of the above methods. Then go over the surface of the filling with a pledget of cotton or spunk, moistened with chloroform. For illustrations of burnishers see Figs. 93 and 94.

Technical Exercises.

Fill several of the cavities, prepared during the study of cavity preparation, using both methods as outlined above.

CEMENT

There are four varieties of cements used in dentistry, each receiving a name depending on its chemical composition. Cements consist of a powder and a liquid, which when mixed together, form a more or less hard mass. The composition of these is largely a trade secret, but for all practical purposes it is as follows:

Classification of Cements

1. Oxyphosphate of Zinc (Basic Zinc Phosphates)	{ Powder, Zinc Oxid (calcined) Liquid, Phosphoric Acid
2. Oxyphosphate of Copper.....	{ Powder, Cupric Oxid Liquid, Phosphoric Acid
3. Oxychlorid of Zinc.....	{ Powder, Zinc Oxid (calcined) Liquid, Zinc Chlorid (deliquesced)
4. Silicates.....	{ Powder { Beryllium, Silica, Aluminum, Calcium Compounds Liquid, Phosphoric Acid

Characteristics.—All of the cements are intended for *temporary* filling work, unless covered by some more permanent material, as they are more or less soluble in the oral fluids. (1) The *Oxyphosphate of Zinc* (basic zinc phosphates) is the most

important of these preparations, and most universally used. It may be obtained in various shades to harmonize with the color of the teeth, and is much more lasting than the oxychlorid. It is largely used for temporary filling work, for cementing crowns and bridges, inlays, orthodontia appliances, and as an **intermediate** (between the filling and cavity). (2) The *Oxyphosphate of Copper* (color inky black) is extremely sticky, and clings tenaciously to dry cavity walls. It is also **antiseptic** (against infection) in character, and markedly bland to sensitive cavities. For this reason it is used for filling cavities, pulp chambers and canals in temporary teeth; also cavities in permanent teeth whose sensitiveness will not permit of proper cavity preparation. On account of its color it has to be confined to posterior teeth. (3) The *Oxychlorid of Zinc* is now seldom used as a filling material, except in root canals, as it quickly disintegrates in contact with moisture. It is extremely **irritating** to vital tissues, and cannot be used in close proximity to the pulp, but is still utilized by some as an intermediate, on account of its antiseptic properties and its white color. (4) The *Silicate Cements*, more recently introduced, are still in a stage of experimentation. Great claims are made for them by their manufacturers as **permanent** filling materials, if properly handled; but there is a great variation in the results so far obtained by different operators. They are *translucent* and more nearly harmonize with the color and appearance of enamel than the other cements.

Advantages of Cements.

1. Non-conductivity (except silicates, most of which require an intermediate).
2. Harmonious color (except oxyphosphate of copper, which is black).
3. Adhesiveness to cavity walls (except silicates).
4. Ease of introduction.

Disadvantages.

1. Lack of edge strength.
2. Low crushing resistance.
3. Solubility in the fluids of the mouth.
4. Incapability of polish (except silicates).
5. Change of molecular form while setting (some expand, some shrink).

Method of Mixing Cements.—Use a *clean* glass slab (Fig. 178), with a heavy, steel, ivory, bone or agate spatula (see Fig. 95). For the silicates, no steel instruments can be used



FIG. 178.—Glass cement slab.

in the mixing or packing, on account of chemical action, and consequent discoloration of the mass. Tantalum, agate, ivory, stellite, or tortoise-shell instruments are recommended. The oxychlorid of zinc and oxyphosphate of copper are mixed to a creamy consistence; the oxyphosphate of zinc to the consistence of putty for filling, and to a creamy consistence for set-

ting crowns, inlays and regulating appliances. The silicates are mixed stiffer than the oxyphosphate of zinc, working in all the powder possible, which will be greater in amount than that taken by the liquid of the zinc phosphate cements.

Directions.—(1) Place, by means of a glass rod or pipette, the necessary amount of liquid in the center of the *clean* slab. (2) Deposit, by tapping the bottle, or with a clean spatula or other convenient carrier, the necessary amount of powder at one end of the slab. (3) Draw in one-fourth of the powder and spatulate thoroughly with a swinging, circular movement. (4) Then draw in another one-fourth of the powder and spatulate as before until thoroughly mixed, continuing to add the powder, and spatulating until the mix is of the desired con-

sistency. (5) For fillings, the mixing should be continued until the cement materially resists spatulation, when it is scraped from the slab, and in some instances rolled into a ball ready for use. Directions accompanying the package specify minute details of mixing silicates and other cements, these varying to some extent, depending on chemical composition.

Method of Packing.—The cavity should be **dry**, with slightly retentive form and bevel not marked. Pack in small pieces, thoroughly condensing with as much force as the material will allow, by means of smooth burnishers, leaving an excess for polishing. As soon as the material is molded to form, allow it to set thoroughly before removing the excess and polishing. Trim and polish with knives, disks and strips. The use of the **matrix** is a necessity in complex cavities, if the best results are desired.

Hydraulic cements require the application of water after molding to form, and before setting.

The manufacturers of De Trey's synthetic cement offer the following instructions for the manipulation of this product.

Correct Technic for De Trey's Synthetic Porcelain

Prepare the cavity with undercuts as for a gold or an amalgam filling, but with margins square, not beveled. If, while a new filling is being inserted, there are any older synthetic fillings within the area which will be kept dry, these older fillings must be protected against desiccation. Coat them with Caulk Cavity Lining or Synthetic Varnish.

Assemble all accessories: stellite, tantalum, ivory, agate or glass instruments for placing; stellite, agate, or glass spatula for mixing; celluloid strips; cocoa butter; cavity lining; heavy glass slab.

Wipe the slab and the spatula with grain alcohol. In hot weather chill the slab to 65 or 70° F. 1

Dry the cavity with alcohol and warm air. Line the cavity, especially when it is deep, with Caulk Cavity Lining. Adjust the celluloid matrix.

Place powder and liquid on the slab. Judge the correct proportions of liquid and powder by estimating their bulk. The average mix requires, by bulk, about five times more powder than liquid. These proportions vary a little with varying temperature.

Place your watch beside the slab.

Begin promptly and complete the mix in a minute and a quarter. This is important. If more than a minute and a half is consumed, proper crystallization will be interfered with.

At once add half the total powder to the liquid; spatulate *quickly*, but thoroughly; follow with successive additions of powder in small quantities. Spatulate each addition *quickly* and thoroughly until it is perfectly smooth. Keep adding powder until the mix passes beyond the semi-liquid state and becomes plastic. In this plastic state it is still soft but does not spread smoothly under the spatula; it breaks into soft, curling ruffles as the spatula moves over it.

With the matrix strip in position, place the Synthetic Porcelain in the cavity. Work it well into the undercuts and against the cavity walls. Fill the cavity until there is slight excess, then bring the celluloid strip over the filling, and hold it firmly immovable for three and a half minutes by your watch. Let the Synthetic set normally. Do not burnish. Do not use either hot or cold air blast.

After three minutes release the strip and immediately coat the filling with cocoa butter. This prevents evaporation of the water-of-crystallization.

It is best to defer the final finishing until a subsequent sitting; but if it is necessary to finish the filling at once, it

must first be left undisturbed for at least 10 (preferably 15) minutes under cocoa butter.

Dress down the filling with abrasives carrying an abundance of cocoa butter. Do not grind steadily. Frictional heat must be avoided. Apply the disk or stone with a light touch and lift. For proximal fillings, where the lingual surfaces are inaccessible to disks and strips, it is permissible to use fine grit, clean carborundum stones carrying cocoa butter. Follow with fine sandpaper disks and strips, and finish with Caulk Dental Polish and Caulk Hard Felt Wheels.

Before removing the rubber dam, wipe off the cocoa butter thoroughly with dry cotton and immediately coat the filling with Caulk Cavity Lining or Caulk Synthetic Varnish.

PRECAUTIONS

Protect the Liquid Against Evaporation and Contamination

1. Shake the liquid before opening the bottle.
2. Expel liquid from the dropper two or three times before taking liquid for the mix.
3. Keep the liquid in a cool place.
4. Keep the dropper in the bottle and always use it to transfer liquid to the slab.
5. Never pour liquid from the bottle.
6. Don't leave the bottle uncapped any longer than is necessary to obtain liquid.
7. Immediately replace the dropper and the bottle cap. Twist the cap to seat it firmly.
8. Avoid accumulation of dirt and incrusted liquid about the neck of the bottle.
9. Don't leave liquid on the slab exposed to evaporation. Begin spatulation at once.

Intermediates

Sensations of heat and cold are rapidly transmitted, by means of the dentinal fibrillæ, to the pulp from the walls of cavities, and as the permanent filling materials are conductors of these physical forces, it becomes necessary in all cavities, except extremely shallow ones, to place **non-conducting substances** between the filling and the walls of the cavity. These materials are known as *intermediates*, and the act of placing them in position is known as **Pulp Protection**. The substances most frequently used are Cement and Gutta-percha. Cement itself is a slight conductor, so that in extreme cases of hypersensitivity a thin layer of Gutta-percha, Chloropercha, or one of the **Cavity Linings**, is applied, and then covered with cement, when the balance of the filling is placed in position. **Cavity Linings** are colorless, transparent liquids, which, on evaporation, leave a thin, non-conducting film on the walls of cavities. Prominent varieties of these are *Cavitine*, *Gilbert's* and *Caulk's Cavity Lining*.

Technical Exercises.

1. Carefully mix a batch of cement, according to the directions given above, stirring in small amounts of the powder at a time, and spatulating *thoroughly* to accomplish mechanical and chemical union of powder and liquid. Roll into a round mass.

2. Mix another batch by adding the powder in large amounts, and avoiding thorough spatulation. Roll into a mass as in No. 1.

3. Place the two mixes in ink or aniline dye for twelve hours, and then compare for cutting consistence as well as amount and penetration of the stain.

4. Insert several cement intermediates in the cavities already prepared, building some up in **step form**.

5. Insert several cement fillings, with and without matrices.

AMALGAM

Definition.—*An alloy or union of mercury with one or more other metals.* Most dental amalgams consist of a combination of mercury with silver, tin, copper or zinc. To these are also sometimes added gold, platinum and other metals.

Alloy.—*A union of two or more metals by means of heat.* The metals are usually melted in a closed electric crucible in an atmosphere of hydrogen. After cooling and hardening, the resultant mass is known as an **Ingot**. The ingot is either filed into small granules or pared into fine shavings, when, after being annealed and carried through certain other processes it is dispensed as alloy for dental use.

Properties of Amalgam

All dental alloys, when mixed with mercury, possess one or more of the following properties, which are imparted to the mass by qualities inherent in the constituents, viz.,

1. Spheroiding.
2. Flow.
3. Shrinkage.
4. Expansion.

Spheroiding.—The tendency to become **round** imparted to the mass by the mercury. It only occurs while the amalgam is hardening or setting, and depends on the amount of mercury left in the mass, the greater the excess of mercury present, the more marked the spheroiding.

Flow.—Many metals, when subjected to constant stress, as from the stress of mastication, possess the tendency to slowly **move from under the stress**, thus gradually changing

their shape. Some, notably tin, possess more of this property than others.

Shrinkage and Expansion.—Some metals, when heated or **amalgamated** (mixed with mercury), shrink, while others expand. The ideal amalgam would be one in which the constituents are so combined as to possess neither of the above qualities, and has not as yet been discovered.

Amalgams possess, in addition to the above qualities, certain advantages and disadvantages.

Advantages.

1. Crushing resistance.
2. Insolubility.
3. Convenience of manipulation.
4. Capability of polish.

Disadvantages.

1. Inharmonious color.
2. Tendency to molecular change.
 - (a) Spheroiding.
 - (b) Flow.
 - (c) Expansion.
 - (d) Shrinkage.
3. Lack of edge strength when built to thin edges.
4. High conductivity.

Metallurgical Properties of Silver, Tin, Copper and Zinc

The various metals in dental alloys possess certain properties, some of which they impart to the mass when combined with mercury. Some desirable qualities of one metal overcome certain undesirable ones of another in the combination, if the metals are combined in the correct proportions.

Silver.

1. Unites with mercury fairly readily in definite atomic proportions.

2. Tarnishes.
3. Expands.
4. Retards setting.
5. Increases edge strength.
6. Lessens flow.
7. Works hard.

Tin.

1. Unites readily with mercury in all proportions.
2. Retards setting
3. Increases flow.
4. Imparts plasticity.
5. Shrinks.
6. Decreases edge strength.

Copper.

1. Unites with mercury with difficulty in definite atomic proportions.
2. Hastens setting.
3. Increases edge strength.
4. Lessens flow.
5. No appreciable expansion or contraction.
6. Tarnishes readily.

Zinc.

1. Unites easily with mercury in definite atomic proportions.
2. Expands.
3. Hastens setting.
4. Diminishes edge strength.
5. Increases flow.
6. Improves color.
7. Imparts plasticity.

Classification of Amalgams

Amalgams may be classified according to the number of constituents they contain into:

1. Binary—one containing mercury and one other metal. Example, copper amalgam.

2. Ternary—one containing mercury and two other metals. Example, Townsend's amalgam, containing mercury, silver and tin.

3. Quaternary—one containing mercury and three other metals (Black's amalgams). Example, mercury, silver, tin and copper.

4. Quinary—one containing mercury and four other metals. Example, mercury, silver, tin, copper and zinc. Most of the amalgams in use today are either Quaternary or Quinary amalgams.

Classification of Alloys

Alloys may be classified into two divisions, as follows:

1. **High-percentage, or Quick-setting Alloys** (containing a high percentage of silver).

Formula: Silver.....	65 to 68 per cent
Tin.....	26 to 28 per cent
Copper.....	3 to 4.5 per cent
Zinc.....	1 to 2.5 per cent

Properties.—(1) Quick setting. (2) Hard working (lack of plasticity). (3) Great crushing resistance and edge strength. (4) Stability of form (minimum of shrinkage, expansion and flow). These alloys are sometimes designated Dr. Black's alloys, but they are wrongly named, as they do not follow his formulæ.

2. **Low-percentage, Slow-setting or Plastic Alloys.**

Formula: Silver.....	43 to 48 per cent
Tin.....	48 to 58 per cent
Zinc.....	1 to 2 per cent

Properties.—(1) Slow setting. (2) Lighter in color. (3) Plasticity (easy working). (4) Less crushing resistance and

edge strength. (5) Greater shrinkage, expansion and flow. (6) Require less mercury to amalgamate.

Amalgam, on account of its inharmonious color, should be confined to the posterior teeth.

Method of Mixing.—The proportion of mercury to the alloy varies in different formulæ and is obtained by testing the batch, or from printed directions on the package. The average is about five parts of alloy to seven parts of mercury by weight. Rapid-setting alloys usually require more mercury. To prevent change of form and to give the greatest edge strength, *all excess* of mercury must be removed in mixing.

Directions.—(1) Place the desired amount of alloy in a wedgewood or glass mortar, preferably the latter, and add the necessary amount of mercury by weight. (2) Mix thoroughly with the pestle (Fig. 179) until the alloy and mercury are completely incorporated. (3) Remove to the *dry* and *clean* palm of the left hand and work vigorously, rapidly and continuously with the fingers of the right hand for from three to five minutes, squeezing frequently and removing excessive mercury until a characteristic *cry* of the mass is heard when in close proximity to the ear. (4) With the thumb and forefinger, forcibly squeeze out all remaining excess of

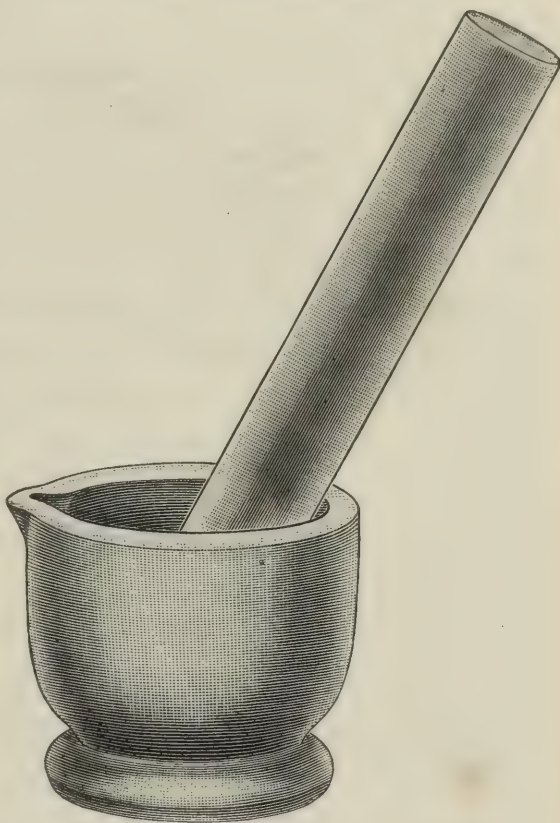


FIG. 179.—Glass mortar and pestle.

mercury; or transfer it to a piece of cloth or chamois and wring with a pair of pliers. Pack immediately.

Method of Packing.—Cut the mass into several small pieces (depending on the size of the cavity) with a flat burnisher. Do not use too large pieces. Pack with *serrated* amalgam pluggers, Black's or Ivory's (Figs. 91 and 92). Pack with steady, forcible hand pressure, condensing thoroughly one piece at a time. Pack toward the walls, **wedging** the several pieces between each other and the walls. If any excess of mercury appears on the surface during the packing and **wedging** process, remove it with spoon or discoid excavators before continuing. Do not use tin foil or gold foil for this purpose on account of the danger of forming a new alloy, possessing new properties. Pack the cavity *overflow*, and allow the mass to set for several minutes before removing the excess. Trim the excess with flat burnishers and knives *toward* the margins, leaving the filling carved to full contour on proximal surfaces, and to proper form on others. The final polishing is deferred for twenty-four, or better forty-eight hours, to allow for complete setting. Directions for polishing are given on page 185.

Cavity Preparation for Amalgam Work varies very little from that for gold. The various steps as described in the chapter on cavity preparation should be carefully and conscientiously completed. Convenience angles are not necessary for starting the filling, the usual retention and resistance form being all that is necessary. Owing to its **lack of edge strength**, the amount of bevel of the cavo-surface angle should be modified as much as conditions will allow.

Matrices.—For filling with amalgam, the presence of four lateral walls to the cavity is a necessity, to prevent the squeezing out of the mass during the application of the great force required during the packing process. In cavities lacking

four walls, the missing wall is supplied by the use of a thin metal band of steel, copper or German silver in the form of a matrix. For technic purposes in the laboratory, a thin band of German silver or copper, $\frac{2}{3}$ or $\frac{3}{4}$ the circumference of the tooth, may be tied in position by means of floss silk, or binding wire, encircling the tooth several times. If the exercises in filling are performed on natural teeth, with extensive cavities, a measurement of the neck of the tooth may be taken, and a soldered band made to completely encircle the tooth.

Technical Exercises.—Fill the cavities in the posterior teeth prepared during the studies in cavity preparation.

NON-PLASTIC FILLING MATERIALS

Tin—Gold

TIN

Characteristics.—Tin, when pure and freshly cut, is **cohesive** (the separate particles clinging to each other), like gold. It rapidly loses this property, though, on exposure to the atmosphere, and gradually becomes **non-cohesive**. Until recently it was worked almost exclusively after the non-cohesive method. There have been introduced several preparations of cohesive tin, one of which was known as **Duplex**, a cohesive tin covered with cohesive gold. Another, which received the trade name of **Crystallia**, was prepared in coarse silver-colored shreds.

Tin is very little used as a filling material today. It may be utilized in the technic laboratory for experimental purposes, as a substitute for gold. For working on the cohesive principle, it may be prepared for use after the following **method**. Take a corundum wheel, $1\frac{3}{4}$ to $2\frac{1}{2}$ inches in diameter, and make a mold in sand or marble dust. After removing

the wheel, pour melted pure tin into the impression in the sand or marble dust, thus duplicating the wheel in tin. Mount on a mandrel on the laboratory lathe, and, while revolving rapidly, cut fine shavings with a sharp carpenter's chisel. These shavings, if worked while freshly cut, will be very cohesive.

Tin is placed on the market in sheets 4 inches square, the same sizes and numbers as gold foil, ranging numbers 2, 3, 4, 5, 6, 8, 10, 20, 30, 40, 60 and 120. It is prepared by the manufacturer in the same manner as gold, by rolling an **ingot** into strips and then rolling thinner for the higher numbers, and beating by machinery for the lower numbers. The number indicates the number of grains to the sheet, viz., a sheet of No. 4 foil weighs 4 grains, No. 10 weighs 10 grains, etc.

Tin foil, as well as gold foil (cohesive or non-cohesive) is prepared for use in various forms by the operator or his assistant.

The principal forms used are :

1. The Roll.
2. The Ribbon or Tape.
3. The Rope.
4. The Cylinder.
5. The Mat or Cushion.

Method of Preparing. (Either tin or gold.)

1. **The Roll.**—(a) Cut a sheet of foil into quarters, thirds or halves, and place a section near one end of a smooth towel, which has been folded lengthwise. (b) Pull the other end of the towel over the foil, and then, bringing it in contact with it, quickly push the towel from you in such a manner as to roll the foil into a loose roll. (c) Repeat the process until the roll is as small as desired (Figs. 180 and 181). Rolls may now be obtained ready prepared by the manufacturer.

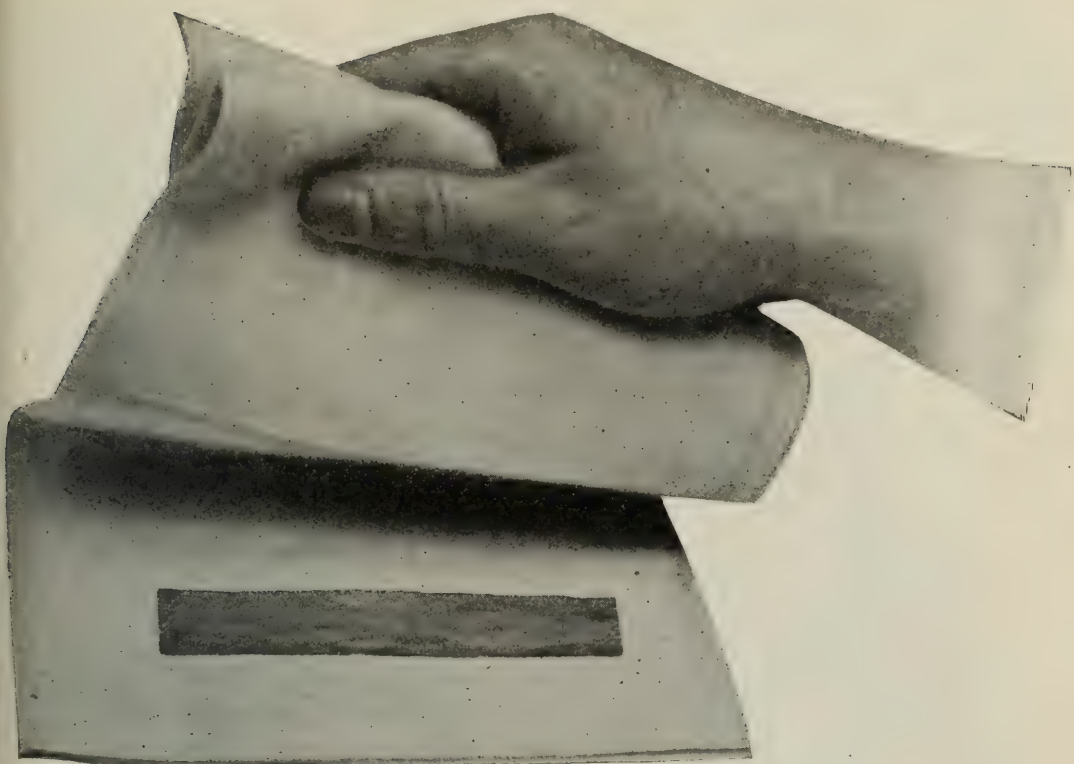


FIG. 180.—Making the roll.

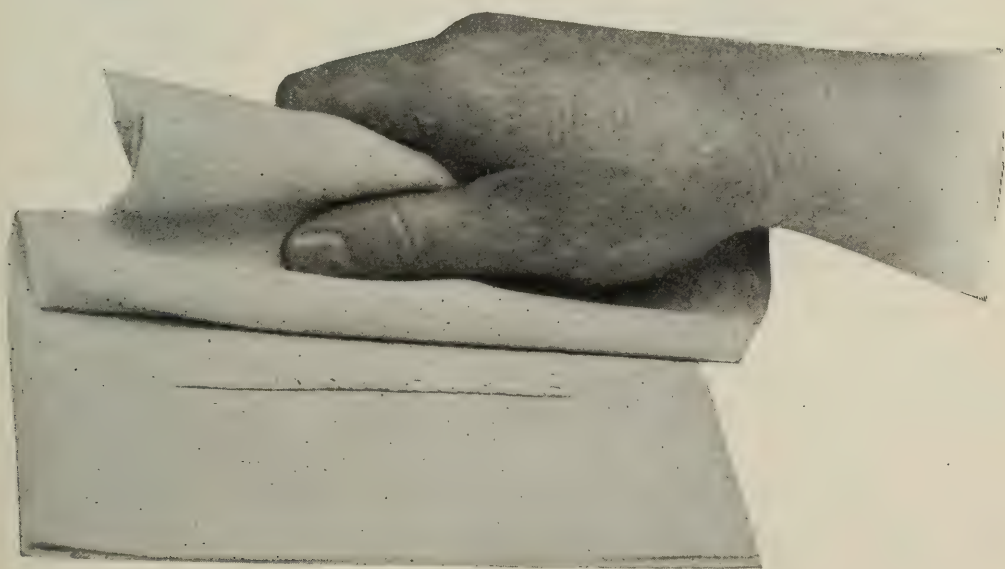


FIG. 181.—The roll completed.

2. **The Ribbon.**—(a) Cut the foil into halves, thirds or quarters, as before, and lay a section on a folded towel or napkin, chamois or spunk, held in the left hand. (b) With a large, clean, plaster spatula, or preferably a **gold folder**, fold the foil lengthwise by placing the folder in the center of the



FIG. 182.—Folding the ribbon.

section, and bringing together the folds of the towel, or other article used, by closing the hand. (c) Repeat the operation, continuing to fold smaller and smaller, until the ribbon is the desired width (Fig. 182).

3. **The Rope.**—(a) Twist a quarter, third or half sheet of foil into a rope between the clean and dry **thumb and fingers** of

both hands, being careful to make the rope as near an equal size throughout its length as possible. The fingers may be covered with finger cots, if the hands are moist. This method is hardly applicable to cohesive gold.

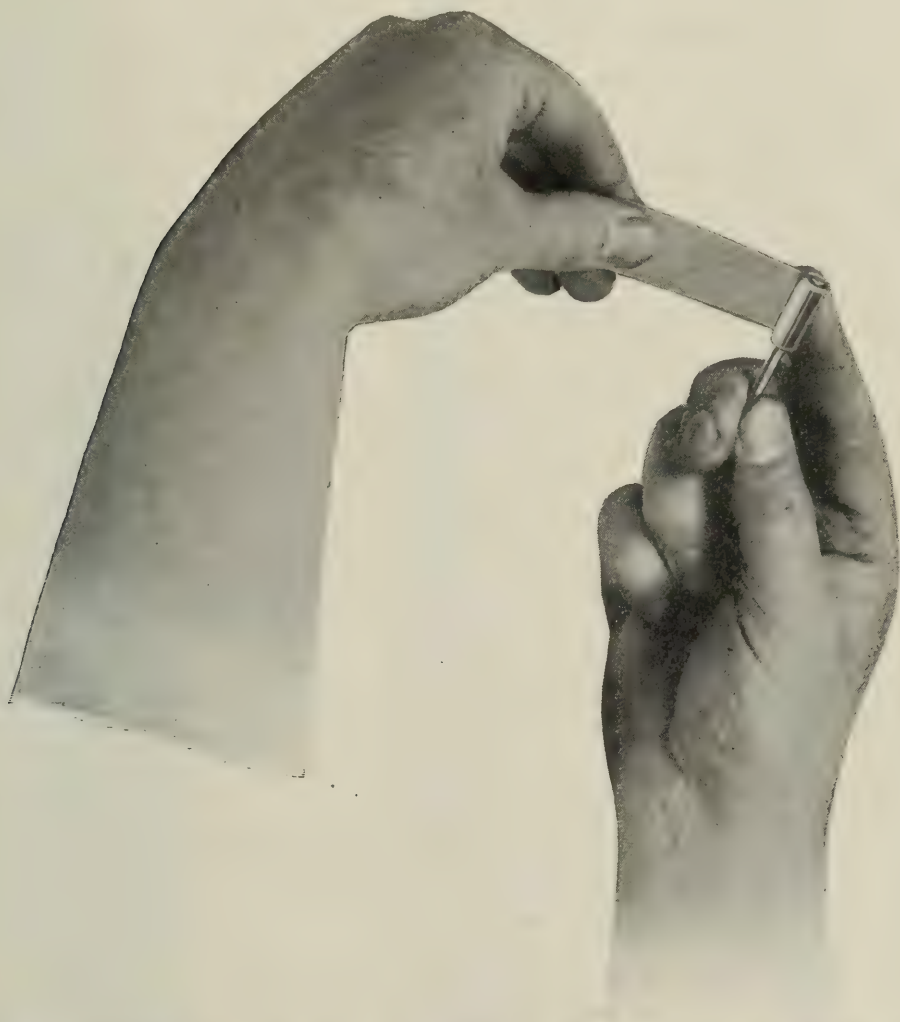


FIG. 183.—Making the cylinder. The broach and cylinder are shown much enlarged.

4. **The Cylinder.**—Roll a ribbon on a three-, four- or five-sided **smooth broach** into a cylinder. The size of the cylinder will be regulated by the *length* of the ribbon, and the length of the cylinder by the *width* of the ribbon. Various sizes and

lengths are required, depending on the size and depth of the cavity. Gold cylinders in both **cohesive** and **non-cohesive** forms are also prepared ready for use by the manufacturer (Fig. 183).

5. **The Cushion or Mat.**—Fold a ribbon lengthwise upon itself with a **spatula**, until made into a mat or cushion. The size will depend on the size of the cavity, and may be varied by regulating the width of the ribbon, the amount of gold used and the number of folds.

Another Method.—Roll a cylinder on a flat-sided broach, and then, after withdrawal from the broach, flatten it more; or roll the cylinder as usual and flatten into a mat.

Advantages of Tin.

1. Non-conductivity. (Lowest of all the metals.)
2. Ease of introduction. (Works rapidly when non-cohesive.)
3. Adaptability to cavity walls.
4. Therapeutic action. (Supposed by some to prevent decay.)
5. Capability of polish. (It takes a high polish, but does not retain it.)

Disadvantages.

1. Inharmonious color. (Oxidizes and darkens readily.)
2. Lack of crushing resistance and edge strength.
3. Flow.
4. Disintegrates in the fluids of the mouth.

Tin is still used by some operators for filling cavities in **children's teeth** on account of its ease of introduction and supposed therapeutic effect; also in **rapid caries** on surfaces unexposed to view and mastication. It is too soft to be subjected to the forces of occlusion in permanent teeth. As the method of working non-cohesive gold and tin is identical, the description here given will apply to both materials.

Method of Working Tin or Non-cohesive Gold.—The cavity preparation is practically the same as for cohesive gold, except that deepening of the convenience angles is

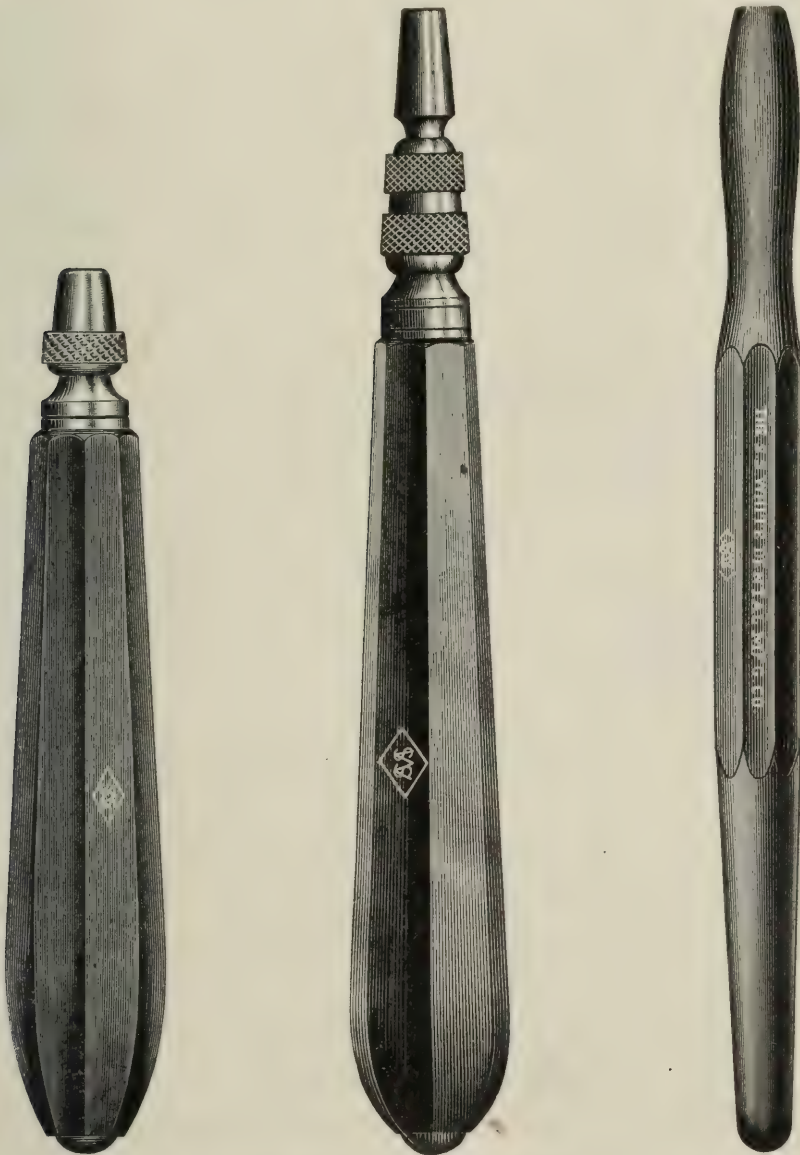


FIG. 184.—Plugger handles.

omitted, and, owing to lack of edge strength in the material, enamel bevels should not be so acute. Simple cavities with four strong walls are a necessity. All filling materials are

packed more or less after a process of **wedging**, but the wedging principle is carried to its fullest extent with non-cohesive gold and tin. Owing to the fact that neither of these possesses the property of cohesion, as the other filling materials do, they are mechanically wedged into the cavity with great force, so that each lamina or layer is dependent on the other to retain it in place. The packing is done with hand pressure, by means of serrated, wedge-shaped pluggers, the final condensation being accomplished by means of mallet force. Owing to the strength of the thrust required for working tin



FIG. 185.—Working gold or tin cylinders (non-cohesive).

and gold by the non-cohesive method, larger handles than those usually employed are necessary (Fig. 184.)

Two methods are employed, depending on the size of the cavity and the individual preference of the operator.

1. **The Cylinder or Cushion Method.**
2. **The Ribbon, Roll, or Rope Method.**

1. **The Cylinder Method.**—The cylinder method is the more rapid when the size of the cavity will admit of its adoption. The cylinders should be of such length that one end will protrude above the orifice of the cavity, while the other rests on the floor or seat. (Fig. 185.)

- (1) Place enough cylinders against the wall farthest away

from the operator to cover the wall. Condense thoroughly against the wall with the plugger. (See Figs. 186 and 187.)

(2) In large cavities place another layer of cylinders against the first layer, and condense in the same direction, holding in position with a plugger in the left hand.

(3) Repeat the procedure on the opposite wall, and then on the two intervening walls, leaving the center of the cavity unfilled.

(4) Force one or more cylinders into the central opening,

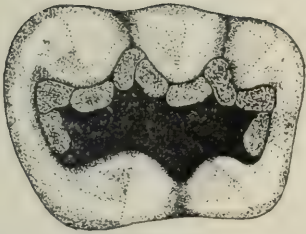


FIG. 186.—Plugging non-cohesive gold cylinders into an occlusal cavity on a lower first molar.

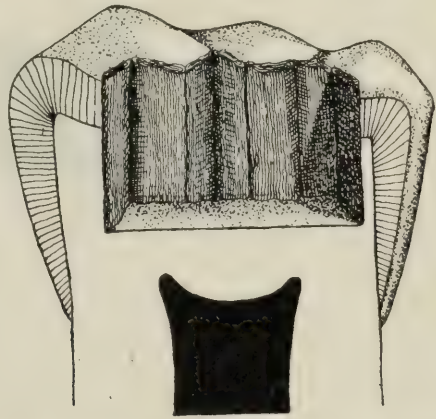


FIG. 187.—Internal view of the same cavity illustrated in Fig. 186, showing cylinders condensed against the lateral walls.

the number depending on its size, ramming them in until the cavity is full.

(5) Force an opening, by means of the wedge-shaped pluggers, into another part of the filling, and pack in one or more smaller cylinders here, repeating this process at other points until it is impossible, by great force, to insert any more cylinders.

(6) Thoroughly condense with foot pluggers by means of mallet force and then burnish.

(7) Trim to shape, grind to shape, or file to shape and burnish again, continuing until the filling is of proper fullness;

then polish. Directions for polishing fillings are given on page 185.

2. **The Ribbon Method.**—This method is practically the same as the preceding, except that instead of the use of cylinders, long ribbons, rolls or ropes are folded upon themselves, starting on the floor of the cavity, against the lateral wall farthest away, and gradually condensing ribbons against all four walls, then in the center, and finally in any place they can be wedged, always carrying the ribbon to the floor of the cav-

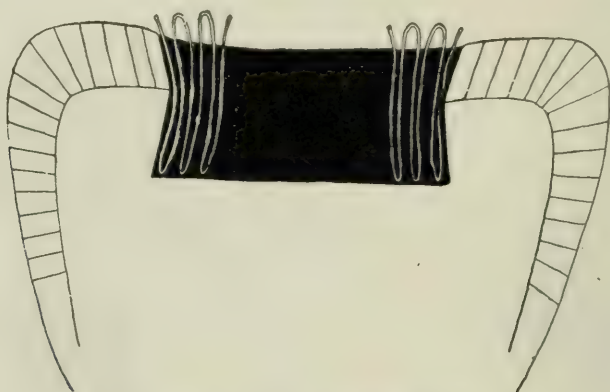


FIG. 188.—The ribbon method.

ity, if possible and extending it well above the margins to allow enough excess for finishing (Fig. 188).

Technical Exercises

1. Prepare rolls, ropes, ribbons, cylinders and mats or cushions, according to the directions previously given.

2. Fill the *simple cavities* prepared in the bone handle, using for one, the rolls; for another, the ropes; for the third, the ribbons; the fourth, the cylinders; and the fifth, the cushions.

3. (a) Take a measurement of the circumference of the handle at the end containing the *compound mortise form*, and

from thin German silver or copper, construct a matrix to be used in filling this cavity. (b) Place the matrix in position and fill the cavity with cylinders.

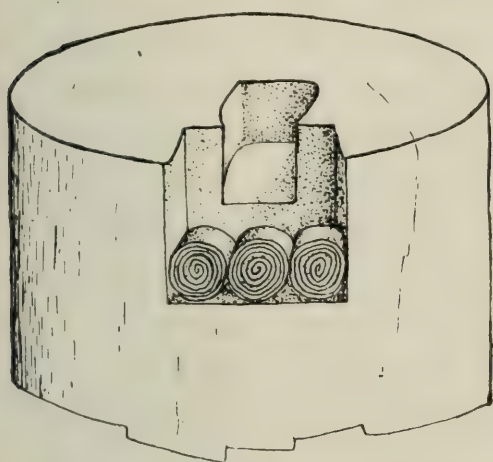


FIG. 189.—Filling the step cavity in the end of the bone handle with cylinders (non-cohesive). Adapting the cylinders to the seat.

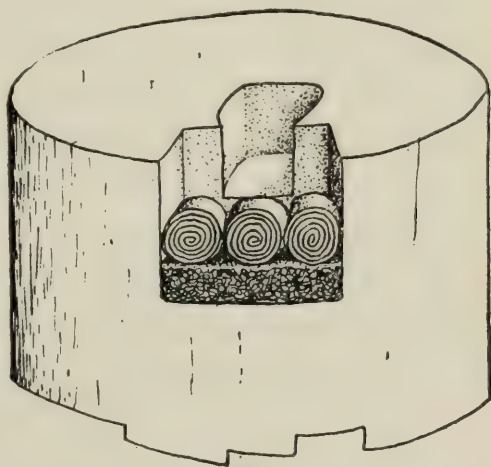


FIG. 190.—Building the non-cohesive cylinders to the level of the step. The matrix is not shown.

Directions.—(1) Prepare cylinders large enough for three of them to cover the *seat*, when condensed against that wall,

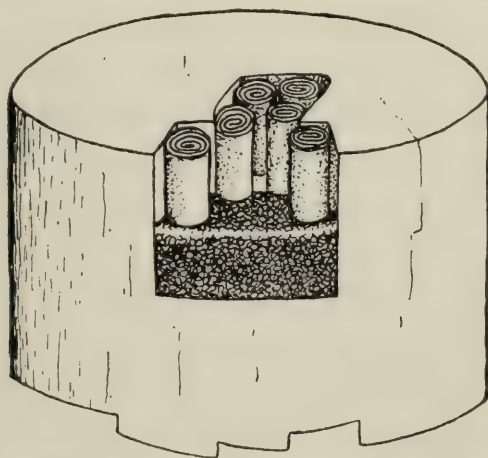


FIG. 191.—The direction of the cylinders is changed and the rest of the filling completed in the manner illustrated.

and slightly longer than the distance from the matrix to the imaginary axial wall, when laid on the seat, with one end

toward the matrix and the other toward the axial wall. (2) Place the cylinders in position, and condense with wedge-shaped, serrated hand pluggers, wedging the middle one in between the other two (Fig. 189). (3) Place in more cylinders, and continue thus until the filling is nearly on a level with the top of the step (Fig. 190). (4) Fill the balance of the cavity as if it were a simple cavity, laying the cylinders in the opposite direction to that used in filling the first portion of the cavity, viz., with one end lying on the step and on that portion of the filling already condensed, and the other end pointing toward the end of the handle (Fig. 191).

4. Burnish and polish all of the fillings.

GOLD

Characteristics.—Gold, for filling cavities, should be pure. In its pure state, uncontaminated, it is cohesive. By **cohesiveness** is meant the property which causes separate particles, when brought in contact, to cling to one another. Gold possesses this property to a higher degree than any other metal. It is taken advantage of in building fillings, by **welding** the various pieces together in the cold state, by means of the plugger. Gold and tin are the only metals possessing to any degree this property of cohesiveness or weldability in the cold state.

Classification.—Gold, for filling purposes, is classified into two varieties, as far as its minute or microscopic structure is concerned.

1. **Fibrous gold.**

2. **Crystalline gold.**

If these two forms be examined under the microscope, the **fibrous** forms are seen to consist of numerous fibers interlacing each other in every direction; while the **crystalline**

forms appear more granular in character. For this reason the fibrous forms make the stronger fillings, although they have a tendency to draw away from cavity walls while being manipulated, owing to a certain amount of resilience or spring in the fibers. The crystalline forms do not possess this tendency, and are more easily manipulated, but are *deceptive and treacherous preparations for students' use* on account of their easy working properties.

1. **Fibrous Gold.**—Fibrous golds are supplied in the form of foil or sheets 4 inches square, ranging number 2, 3, 4, 5, 6, 8, 10, 20, 30, 40, 60 and 120. The higher numbers are rolled out by the manufacturer from an **ingot**, while the lower numbers are beaten by machinery.

Fibrous gold is classified into (a) **Cohesive**; (b) **Semi-cohesive**; (c) **Non-cohesive**.

(a) The **cohesive foils** are, after being rolled or beaten, annealed by heat and put up in books containing $\frac{1}{8}$ oz. Before using, the dentist usually re-anneals them, as they will in time lose much of their cohesive property on exposure to the atmosphere, accumulating gases, which may be driven off by heat.

(b) The **non-cohesive foils** have deposited on their surface certain substances, such as iron, sulphur, or phosphorus, which destroy their cohesive property.

(c) Some foils are supplied as **semi-cohesive**, in which the cohesive property is not developed to its fullest extent. These are preferred by some operators. The non-cohesive and semi-cohesive forms are also supplied in $\frac{1}{8}$ oz. books, the numbers running the same as the cohesive foils.

2. **Crystalline Gold.**—There are many varieties of this form made by various manufacturers, all of which are highly cohesive, and receive different names. *Watt's Crystal Gold*, *Solila*, and *Corona* are preparations supposed to be both

fibrous and crystalline in nature. These preparations are not in sheet form, but are supplied in strips, bricks, mats and similar shapes.

Advantages of Cohesive Gold.

1. Insolubility.
2. Adaptability to cavity walls.
3. Great crushing resistance and edge strength.
4. Freedom from molecular change.
5. Capability of polish.

Disadvantages.

1. Color.
2. High conductivity.
3. Difficulty of manipulation.

It will be seen that cohesive gold more nearly fills the requirements of an ideal filling material than any other substance yet introduced, its chief disadvantage being its objectionable color. Until something less conspicuous, having the necessary lasting qualities, is introduced, though, it will continue to maintain, as it has in the past, its position as **King** of filling materials.

Indications for Use.—Gold may be placed in any portion of the mouth where proper access may be obtained, where its color is not objectionable, and the strength of cavity walls permits.

Non-cohesive gold may be used, on account of its **rapidity of manipulation**, in simple cavities with four strong walls, located on surfaces not subject to wear. It may also be used in combination with cohesive gold, for beginning fillings on the gingival wall in proximal cavities, or on the pulpal or axial wall in others, as a time-saver. It is not indicated on surfaces subjected to the stress of mastication, or for contour work. **Cohesive** gold, though, is now used **almost exclusively**, on account of its great crushing resistance, its ability to con-

tour and to be built out over long bevels to thin edges, and also on account of greater familiarity on the part of modern operators with its working properties.

METHOD OF WORKING COHESIVE GOLD

Annealing.—Annealing is for the purpose of driving off volatile surface impurities, and rendering soft. There are **two methods**, as follows, *viz.*,

1. Cut the gold into small pieces, and lay on the tray of a **gold annealer**, thus preventing contact with the impure gases of the flame, as well as the tendency to overheating and irregular annealing. The best form of annealer is the electric, though good results are obtained with the ordinary forms, constructed for use on the alcohol lamp or Bunsen burner (Fig. 192).

2. Grasp the gold near one end with foil carriers, and pass back and forth over the **flame of an alcohol lamp** or Bunsen burner. Then grasp at another point, and repeat the procedure, heating the gold to a dull red color, being careful not to overheat or melt any portion. There are *three disadvantages* in this method. (a) The danger of overheating or melting the gold, rendering it brittle and destroying its softness. (b) The danger of overheating one part and underheating another. (c) The danger of gases from an impure gas flame, or a charred wick of an alcohol flame, destroying some of the natural cohesive property of the gold. The point first grasped by the pliers is not annealed because the handles of the pliers carry off the heat at that point, hence the necessity of grasp-



FIG. 192.—Kerr flame shield and gold annealer with alcohol lamp.

ing at a new point after the first annealing, and repeating the process to prevent the occurrence of partially annealed spots in the gold, with the resultant tendency to *pitting* in the filling.

The use of a gold annealer is the most satisfactory method. If a mica or soapstone tray is used, the student should be careful to see that the flame of the lamp is given sufficient heat to properly anneal the gold, else poor fillings from failure to bring out its full cohesive property will be the result.

Gold Pluggers.—Gold pluggers are made with numerous serrations in their face, these serrations being of a wedge or pyramidal shape. A set of gold pluggers should possess serrations of the same size in each instrument, in order that when change of instruments is made during the gold-building operation, the pyramids may properly **interdigitate** (see Figs. 87, 88, and 89). In case instruments with different size serrations are used, when a change to a new instrument is made, the surface of the gold should be gone over with the new instrument before adding a fresh piece of gold.

There are three principal **methods of plugging** cohesive gold:

1. By means of hand pressure.
2. By the use of the hand mallet.
- 3 With some form of mechanical mallet.

For *starting fillings*, hand pressure alone should be used, while for *building the main body* of the filling, either the hand mallet or some form of mechanical mallet is utilized. For operations in the technic laboratory, the student may confine himself to hand pressure and the hand mallet, as very excellent work may be done by this method, although, if desired, the automatic mallet may be used in addition. The operations may be performed with **cohesive tin** instead of gold, and excellent practice obtained in that manner. The student should perform, though, at least a few gold-building operations.

General Directions for Proximal or Proximo-Occlusal Cavities

1. Take up a small piece of gold, and carry it by means of the foil carriers, into the **point angle** farthest distant, holding it in position with a gold holder in the left hand.



FIG. 193.

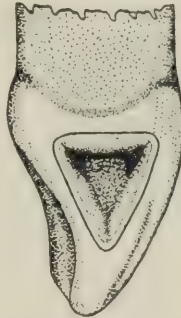


FIG. 194.

FIG. 193.—Stages in filling a proximal cavity on an incisor tooth with cohesive gold. First fill the linguo-axio-gingival and the labio-axio-gingival point angles with a half millimeter plugger by means of hand pressure.

FIG. 194.—Unite the two portions of gold by building along the gingivo-axial line angle. Then change to a $\frac{3}{4}$ millimeter plugger and condense with mallet force.

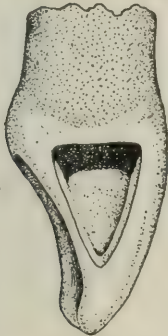


FIG. 195.

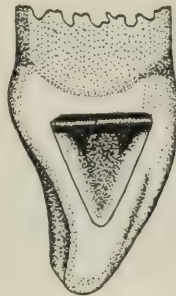


FIG. 196.

FIG. 195.—The gingival wall and margin of the cavity shown in Figs. 193 and 194 are now covered.

FIG. 196.—The gold has been "levelled up" and is now being carried downward along the axial wall.

2. **Condense thoroughly with hand pressure**, by means of a half millimeter gold plugger, directed equally toward the three walls forming the point angle, continuing to hold in

position with the gold holder until the point angle is filled, when, if the angle is properly prepared, the gold will remain where placed (Fig. 193).



FIG. 197.—Build the gold out to full contour along the axial wall, keeping the lingual portion in advance.



FIG. 198.—Fill the incisal point angle and unite it to the main body of gold, completing the filling on the labial side.

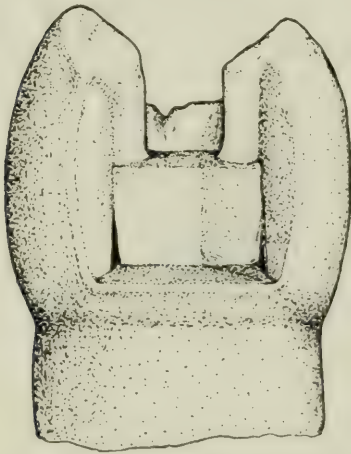


FIG. 199.—Proximo-occlusal cavity in a bicuspid tooth, prepared for a gold filling.

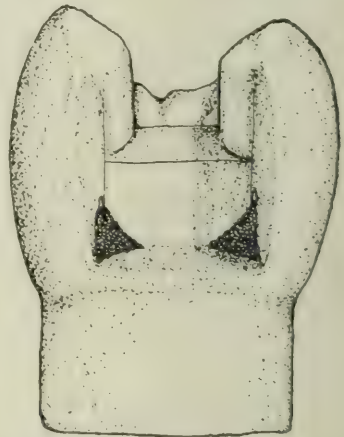


FIG. 200.—The gingival point angles filled.

3. Repeat the same procedure in the opposite convenience angle (Fig. 193).
4. Build the gold **along the connecting line angle**, con-

densing equally against the two walls which form the line angle (Fig. 194), when the gold is now thoroughly anchored in position.

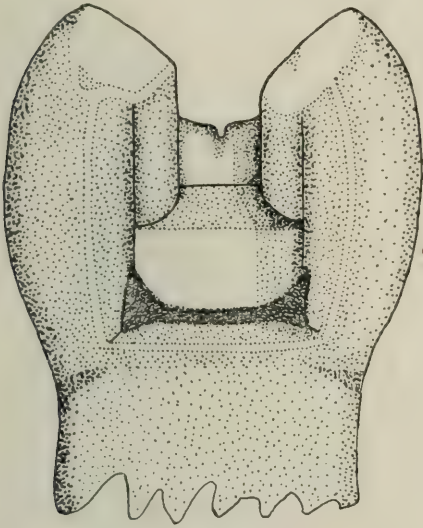


FIG. 201.—The gold has been built along the gingivo-axial line angle, uniting the gold previously condensed into the point angles.

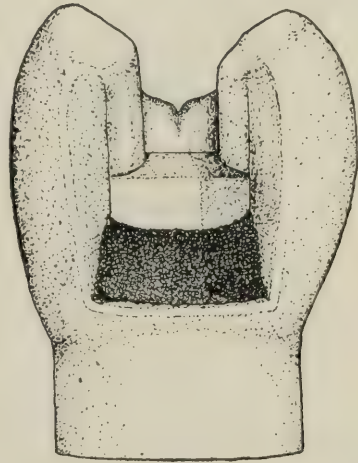


FIG. 202.—The gingival wall covered.

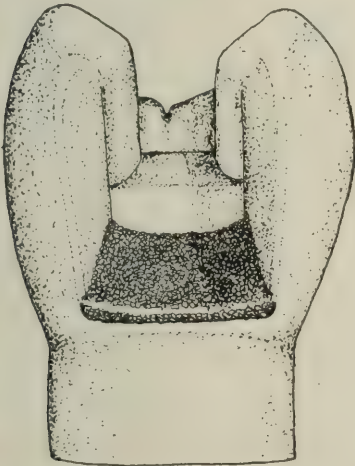


FIG. 203.—Building along the axial wall.

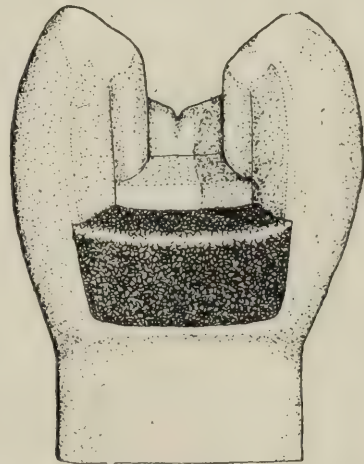


FIG. 204.—The top of the step nearly reached.

5. Changing to a $\frac{3}{4}$ -millimeter, or 1-millimeter plugger, depending on the size of the cavity, **condense thoroughly with hand mallet, or other form of mallet.**

6. Build the gold along the **axial** wall in proximal cavities not involving the angle, until the other point angle is reached,

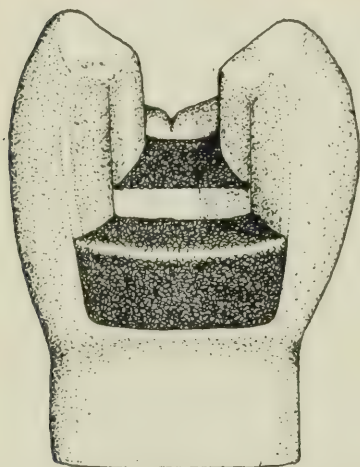


FIG. 205.—Covering the pulpal wall (the step).

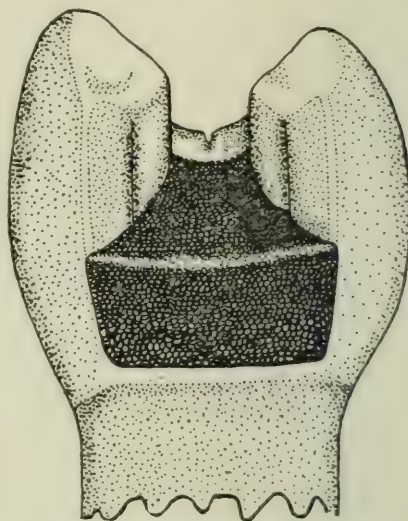


FIG. 206.—The two portions of the filling are united and further progress has been made in the building operation.

when it is filled separately as before with **hand pressure**, then condensed with the **mallet** and afterward united to the main body of gold (Figs. 195 and 196). In proximo-occlusal cavities the same procedure is followed until the top of the step is reached. Then fill the convenience angles separately at the **far end of the step**, later uniting them, and then building the gold across the step and uniting it with the first portion of the filling (Figs. 199 to 206).

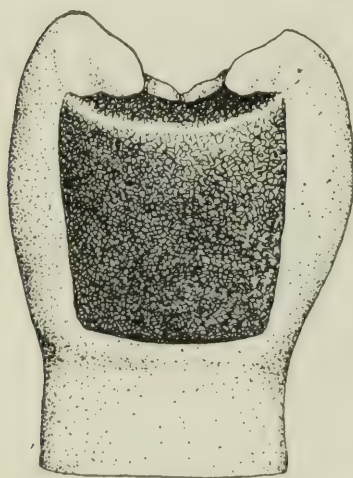


FIG. 207.—The two portions united and the filling completed.

7. Build the rest of the filling to proper restoration of **contact and occlusion form**, leaving an excess of gold over the cavo-surface angle, and the balance of the surface to allow for finishing (Fig. 207).

8. **After-Condensation.**—Go over the entire filling with a small foot plugger, and thoroughly condense.

Ten Rules for Plugging Cohesive Gold

1. **Pluggers.**—Use pluggers ranging from $\frac{1}{2}$ to 1 millimeter in size, $\frac{1}{2}$ millimeter for starting in convenience angles, and larger sizes up to 1 millimeter for building.

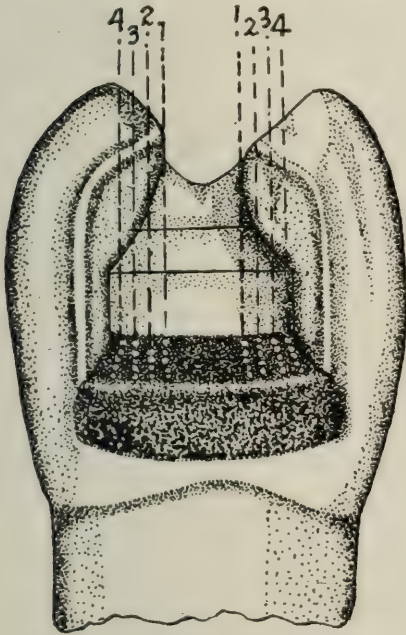


FIG. 208.

FIG. 208.—Illustration showing the process of stepping. The plugger is "stepped" in definite lines a distance represented by the diameter of its face. Number 1 represents the first line stepped, number 2 the second line, etc.



FIG. 209.

FIG. 209.—Showing the gold built in thin laminæ and placed in a direction to best resist the force of occlusion.

2. **Stepping.**—Step the plugger in definite lines, moving it only a distance of the diameter of its face, after each thrust or blow, to avoid *bridging* and imperfect condensation (Fig. 208).

3. **Condensing.**—Pack the gold in small pieces and thin layers, condensing each layer thoroughly by the *stepping process*, to assure thorough condensation.

4. **Direction.**—Pack in the general direction of the long axis of the tooth, wherever possible, in order to avoid lateral strain on the pericementum and to place the layers of gold in a plane with the plane of the forces of occlusion, so that the crushing stress may be resisted to the utmost (Fig. 209).

5. **Angle of Force.**—Incline the shaft of the plugger about 6 centigrades from the lateral walls of the cavity, and pack from the center toward the walls (Fig. 210).

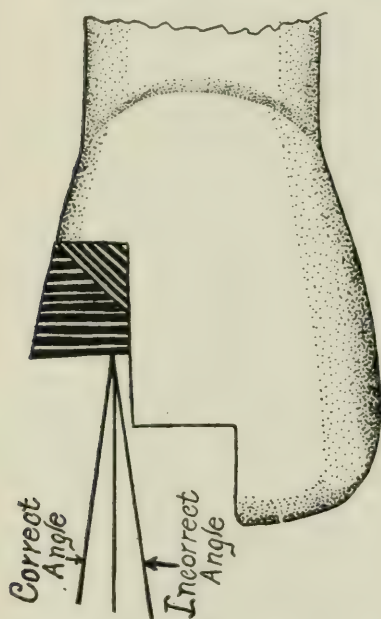


FIG. 210.—Showing correct and incorrect angle of force in plugging gold in a proximo-incisal cavity.

6. **Contour.**—In proximal cavities build each layer out to full contour, to avoid the necessity of “pasting” gold on afterward, with resultant weakening of the surface of the filling.

7. **Lingual Wall.**—In proximal cavities in anterior teeth, build the lingual portion in advance, finishing on the labial side, and see that the lingual margin is thoroughly covered, as each layer is adapted (see Figs. 194 and 195).

8. **Margins.**—Do not allow the plugger to come in contact with the margins, on account of danger of fracture of the enamel, but interpose a layer of gold before the blow is struck.

9. **Annealer.**—Use a gold annealer, with the flame adjusted to give sufficient heat.

10. **Wedging.**—In packing toward the lateral walls, wedge the gold in between the wall approached and the layer being condensed, in order that the filling may be gripped by the natural resilience or elasticity of the dentin.

Technical Exercises

Fill several of the prepared cavities on the technic form, or in the extracted teeth, with cohesive foil.

Advantages of Non-Cohesive Gold.

1. Insolubility.
2. Adaptability to cavity walls.
3. Ease and rapidity of introduction.
4. Capability of polish.

Disadvantages.

1. Color.
2. Non-weldability and consequent lack of crushing resistance, with the result that it is not indicated on surfaces exposed to mastication and cannot be contoured.
3. High conductivity.

For the method of preparation and working of non-cohesive gold, the reader is referred to the description of tin (see page 169), these two materials being worked after the same method.

METHOD OF POLISHING FILLINGS

1. Fillings in Pit and Fissure and Gingival Third Cavities.

—(a) **Remove the excess** with Black's or Pichler's trimming knives, "flexo" or Black's files, carborundum stones, Gem points or sand and emery disks, depending on the size, location and shape of the filling. The general direction of the cutting should be *toward the margins*. Do not use rough stones as the outline of the cavo-surface angle is approached, for fear of damaging the margins; changing to knives, fine files, Gem stones or disks for this purpose. Trim or grind the filling down until the original shape of the tooth is restored, the operation on occlusal surfaces frequently requiring the application of much esthetic taste as well as mechanical skill

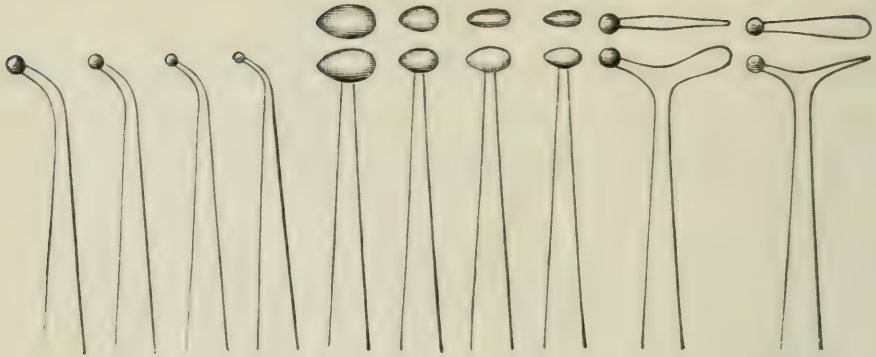


FIG. 211.—Gold burnishers.

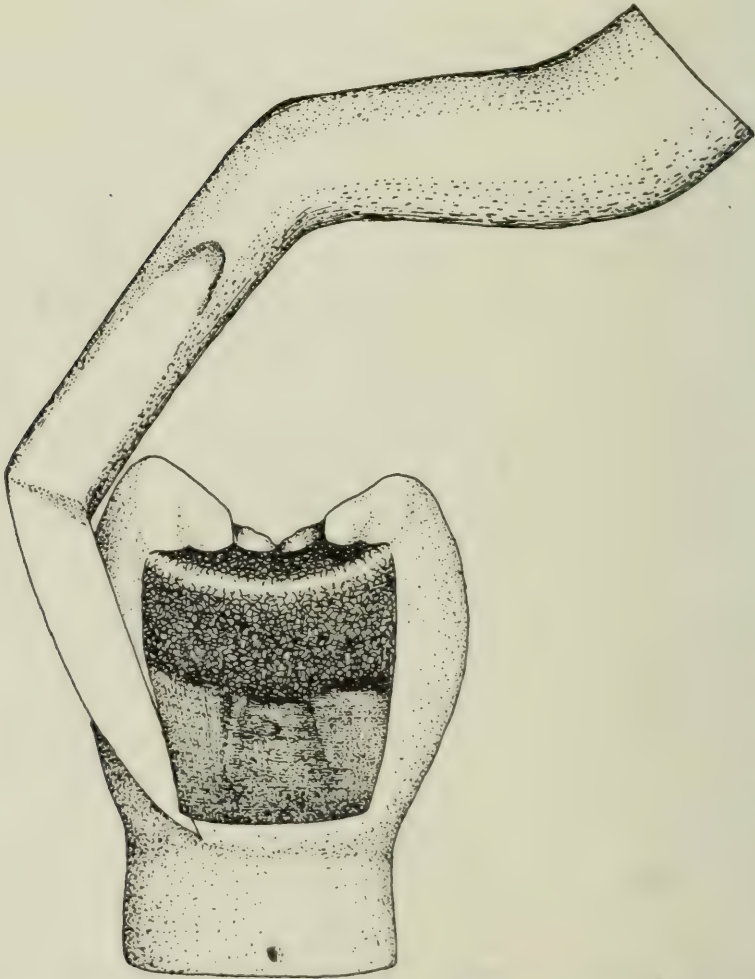
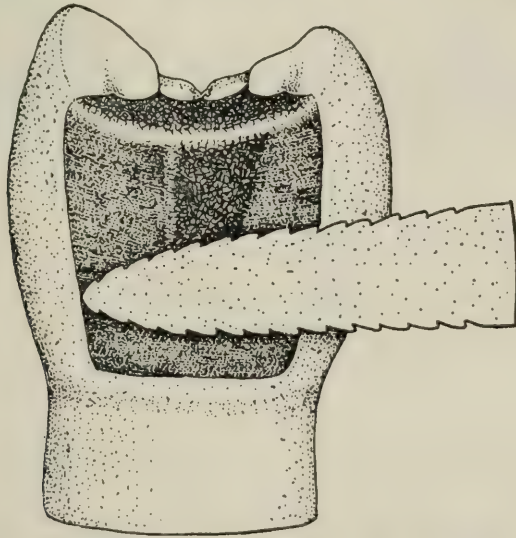


FIG. 212.—Removing the excess at the gingival portion with a Black knife.

to carve grooves and cusps to their original anatomical form. (b) **Polish**, first with garnet and then with cuttle-fish disks, in locations where these will readily reach, finally going over the surface, if a specially high finish is desired, with crocus disks, or with chamois, felt, or moose-hide buffers, dipped in whiting or rouge. In pits and fissures, where the disk is not applicable, after the final shaping of the filling, the surface may be gone over with finishing burs, which will give a high burnish; or, if preferred, the use of wood points and wet pumice may be resorted to, finally going over the sur-



[FIG. 213.—Application of the file to the gingival portion.

face again with the chamois, felt or moose-hide wheels carrying whiting or rouge.

2. **Fillings in Proximal Cavities.** (a) **The Gingival Portion.**—After thorough burnishing (Fig. 211), the excess at the gingival portion, up to a point slightly gingival to the contact point, is first removed by means of a saw in a Wilson or Kaeber saw frame, or by the use of keen Pichler or Black knives. This portion is then gone over with the Black files, or the Rhein approximal trimmers until the filling is flush with the gingival margin (Figs. 212 and 213).

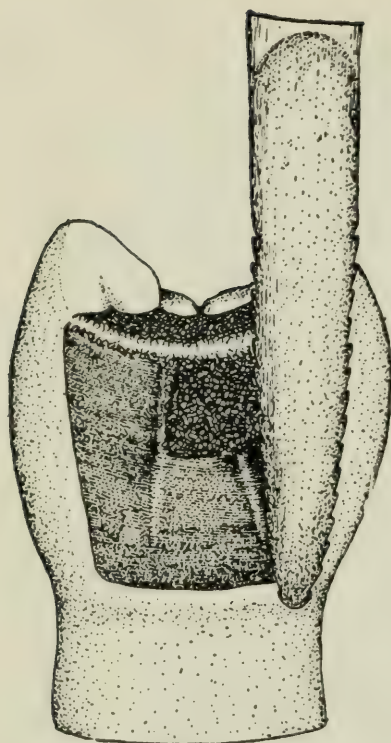


FIG. 214.—Filing the buccal and lingual portions.

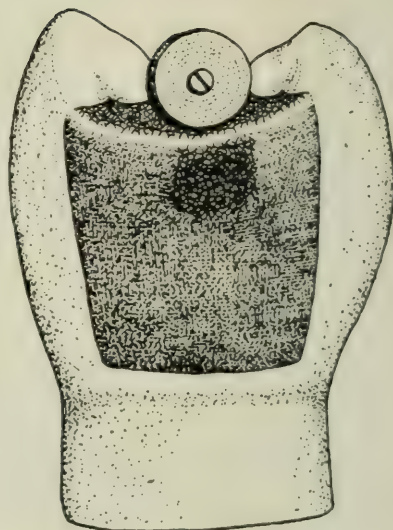


FIG. 215.—Use of the stone on the occlusal portion.

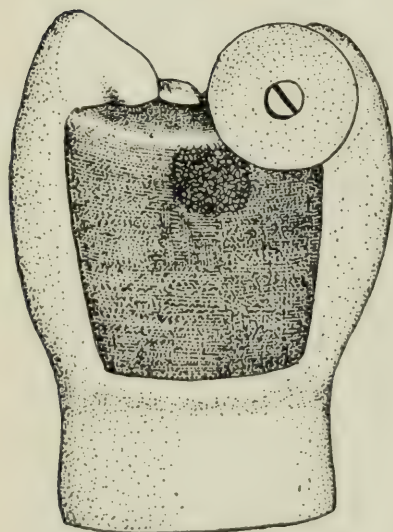


FIG. 216.—Polishing with the disk.

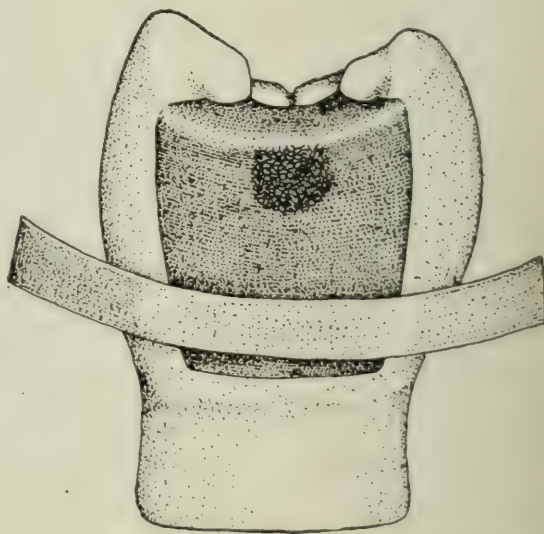


FIG. 217.—Application of the polishing strip to the inter-proximal portion.

(b) **The Buccal or Labial and Lingual** portions then receive attention, the excess being removed by the use of the knives, the files, or, where convenient, small stones, finishing burs, sand and emery disks (Fig. 214).

(c) **The Occlusal or Incisal portions** next receive attention in the same manner, leaving the contact point untouched (Fig. 215).

(d) **The entire filling** is then gone over again, with the exception of the contact point, with the finer polishing strips

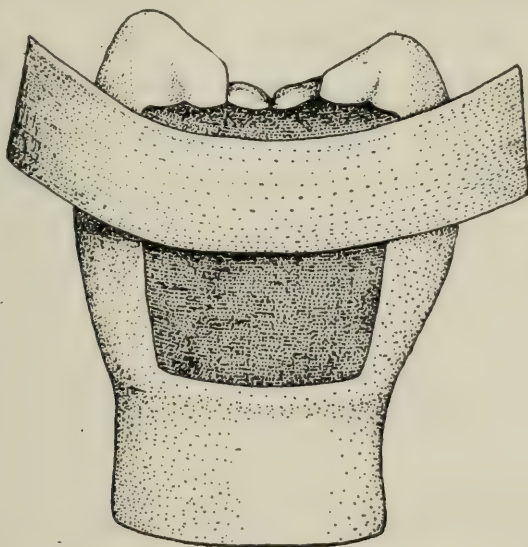


FIG. 218.—Polishing the contact point.

and disks, using the disks only on the labial, buccal, lingual, incisal or occlusal margins, utilizing the strips for the shaping of the inter-proximal portion (Figs. 216, 217).

(e) **The contact point** should now remain as a small marble contact, as nature intended it, and is now gone over (being careful not to flatten it) with a fine linen polishing strip, making increased separation, if necessary, for this purpose (Fig. 218).

(f) **In case a still higher finish is desired**, the exposed surfaces are now gone over with whiting or rouge on the buffers.

CHAPTER VII

THE GOLD AND PORCELAIN INLAY

An inlay may be defined as a material, usually gold or porcelain, which has been so constructed out of the mouth and later cemented in one piece into the prepared cavity of a tooth, that it will perform the required functions of a filling.

The use of the porcelain inlay in dentistry has been largely discontinued since the marked improvements made in the silicate cements. There are a few operators who are still enthusiastic about the material, and who are obtaining splendid results with it, but it is felt that with the improvements which will undoubtedly continue to develop in the manufacture and working of the silicates, porcelain art in dentistry as far as the inlay is concerned, is largely a matter of past history.

Fused porcelain is still of great value in the construction of the jacket and other forms of crown, as well as of certain types of bridge work, and will probably continue so for a long time. The difficulty of obtaining proper shades, as well as the time and great skill required in manipulation are the principal drawbacks to its use.

The modern cast gold dental inlay was devised by Dr. William H. Taggart, of Chicago, and introduced into dentistry in 1907. Before that time, however, other methods of constructing gold inlays were in more or less limited use in dentistry, but were largely unsuccessful, on account of the crudeness of the procedures followed and the poor results obtained. Although the profession is greatly indebted to Dr.

Taggart for his work in greatly improving the methods of constructing the gold inlay, it must be said that these methods were not entirely original with him, but were a revival or adaptation of very old principles, used over long periods of time in mechanics and the arts. The "Cire Perdue," or disappearing model, or "wasting wax" process of casting was in common use in the founding art thousands of years ago. This is also true of the centrifugal and pressure methods of casting.

THE GOLD INLAY

The **indications** for the gold inlay may be mentioned as follows, viz.:

1. For restoration of abraded surfaces, owing to its density.
2. As a substitute for the shell crown in badly broken down posterior teeth.
3. As a time saver to operator and patient.
4. In cavities where prolonged exclusion of moisture is impossible.
5. In invalid, young, or old, patients, unable to bear prolonged operations.
6. In teeth with weakened periodontal membranes.
7. As abutments for bridge-work.

Gold inlays are, as a rule, **contra-indicated** in small cavities, shallow cavities, and proximal cavities not involving the angle, unless these latter are large and the lingual wall is lost, thus allowing ready withdrawal of the wax model and insertion of the inlay from the lingual aspect. Since the introduction of the gold inlay and the synthetic filling, the use of cohesive gold as a filling material has rapidly diminished. However, there are still many conditions which justify its use, and the gold building operation far exceeds

all others in the college clinic for developing technical skill and manipulative ability.

Cavity Preparation

Access for inlay work should be obtained principally by separation of the teeth and not by extensive cutting of tooth

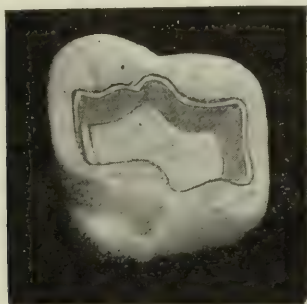


FIG. 219.—Cavity preparation for a gold inlay on the occlusal surface of an upper molar.

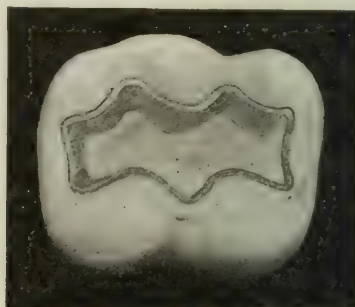


FIG. 220.—Inlay preparation on occlusal surface on a lower first molar.

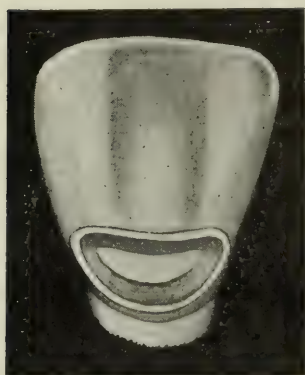


FIG. 221.—Labial cavity on an upper central incisor.



FIG. 222.—Inlay preparation on a cuspid with more extensive caries involvement than that shown in Fig. 221.

structure. All cavity preparations, whether for inlay or other types of restoration should be made with the saliva excluded, to perfect the view of the cavity, to diminish sensitivity, and to maintain asepsis. Cavity preparation for the gold inlay

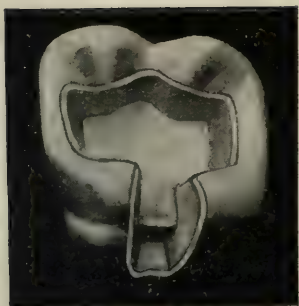


FIG. 223.—Step form on an upper molar involving the lingual groove.

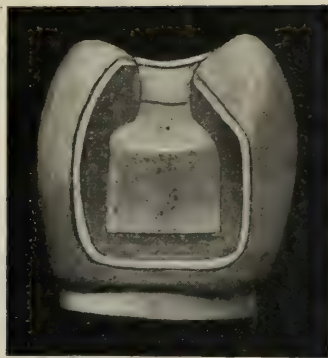


FIG. 224.—Proximo-occlusal cavity on a bicuspid.

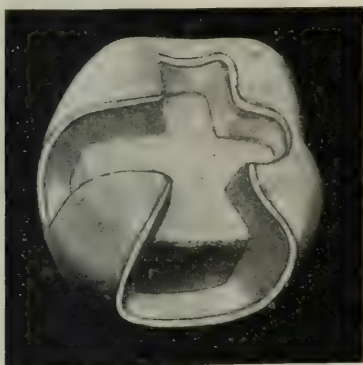


FIG. 225.—Double step cavity on a molar.

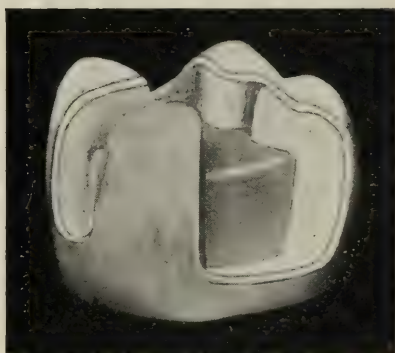


FIG. 226.—Another view of the cavity seen in Fig. 225.



FIG. 227.—Cavity on an upper molar, showing dovetailed occlusal step for locking the inlay into position.

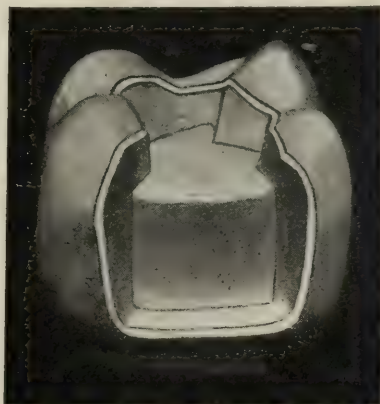


FIG. 228.—Inlay preparation involving central and distal fossæ and proximal surface on a molar. The inlay will be keyed into position by the dovetailed occlusal step.

differs very little from that for other materials except in the method of retention and in the character of the marginal bevel.

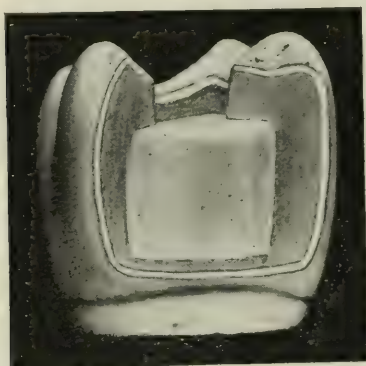


FIG. 229.—Proximo-occlusal cavity on a molar.



FIG. 230.—Step form in a bicuspid.

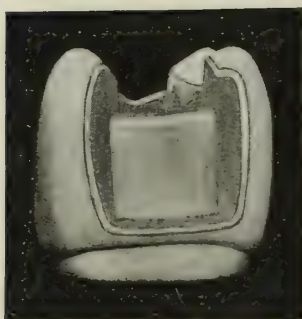


FIG. 231.—Another view of the cavity shown in Fig. 229.

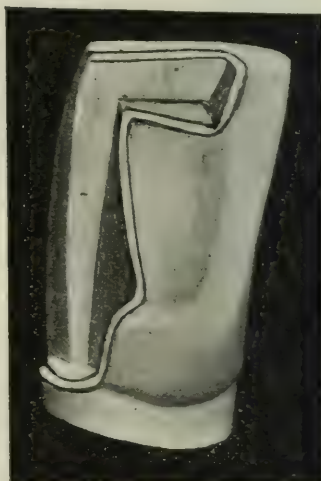


FIG. 232.—A step form involving the mesial, lingual and incisal surfaces of an abraded central incisor. The inlay is locked in place by the incisal step.

Adequate *Resistance Form* should always be obtained. Walls should not be made absolutely parallel, but should diverge slightly, to allow for proper “draw” (see Figs. 219, 220, 221, 222, 223, 224, 225 and 226). *Retention* should be

provided, wherever possible, by the use of the dovetail mortise form, either in the form of an occlusal (Figs. 227, 228, 229, 230



FIG. 233.—Labial view of the cavity shown in Fig. 232.

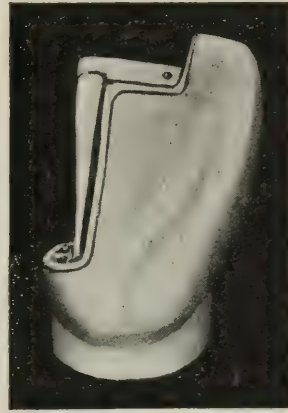


FIG. 234.—Preparation for a pin inlay on an incisor. Lingual view.



FIG. 235.—Labial view of the cavity seen in Fig. 234.



FIG. 236.—A mesio-distal cavity on a lateral. Holes drilled for insertion of pins on the gingival walls.

and 231), lingual or incisal dovetail step (Figs. 232 and 233), thus keeping the inlay in place. Additional retention may also be obtained by the use of 20-gage platino-iridium or clasp

metal pins on gingival, incisal or pulpal walls of vital teeth (Figs. 234, 235, 236 and 237) or of 16-to 14-gauge pins of the same material, inserted into the canals of pulpless teeth



FIG. 237.—Labial view of the cavity seen in Fig. 236.



FIG. 238.—Cavity prepared for insertion of a pin inlay in a pulpless cuspid tooth.



FIG. 239.—Extensive preparation for a pin inlay in a pulpless bicuspid. The lingual cusp is to be restored with gold.



FIG. 240.—Another view of the cavity shown in Fig. 239.

(Figs. 238, 239 and 240); deepening of the point angles is also considered admissible, the cutting being done entirely at the expense of gingival or pulpal walls, with the result that the

wax of the model may be forced into them and, being withdrawn, will form small spurs on the inlay, producing the



FIG. 241.—An excellent preparation for an inlay on the proximal surface of a central incisor involving the angle.

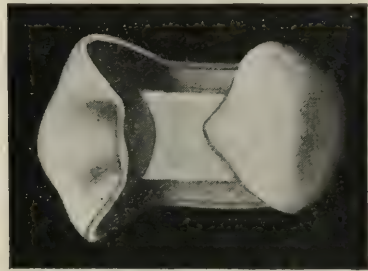


FIG. 242.—An M. O. D. cavity on a bicuspid.



FIG. 243.—M. O. D. cavity on a bicuspid. Much more extensive involvement of the cusps. The entire occlusal surface will be restored with gold.



FIG. 244.—A badly broken down molar. It has been necessary to remove the disto-lingual cusp for reasons of strength.

same result as if pins had been used. Extra retention may also be accomplished, if desired, by temporarily filling in undercuts in the cavity with wax of a different color from

that used in the model. Before setting the inlay, this is removed, affording space for increased body of cement. Some operators also advocate removal of wax from the under surface of the model before casting, thus affording an increased

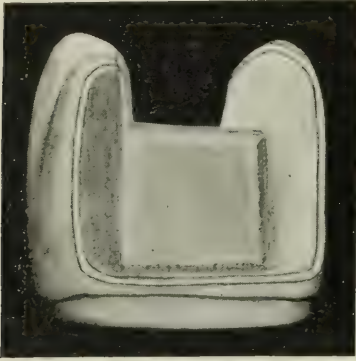


FIG. 245.—Same cavity shown in Fig. 244.



FIG. 246.—A badly involved molar. The entire occlusal surface will be restored in gold. The points of the cusps have been removed for reasons of strength.



FIG. 247.—Same preparation illustrated in Fig. 246.



FIG. 248.—Preparation for a Carmichael attachment.

grip of the cement on the inlay after it is cast and set. Some also advise the undercutting of the walls of the cavity after casting the inlay and before setting, for the same purpose. The author does not advocate either of these latter procedures, as routine practice, since he believes that more ideal results

are procured by obtaining a perfect fit of the inlay to the cavity walls. *The Cavo-surface Angle* should be made obtuse and the bevel angle should not be deeply buried, thus resulting in a long, thin bevel and a feather edge to the metal. The bevel should in most cases extend one-fourth to one-third the thickness of the enamel and range from 6 to 10 Centigrades outward. Margins over which the wax model has to travel during withdrawal should be especially highly polished, to avoid roughness and marring of the wax. Before setting the inlay, the cavity should be given a bath, first in chloroform to remove traces of wax and fatty matter, and then in alcohol. A study of the additional cavity preparations illustrated in Figs. 241 to 248 will be helpful.

The Wax Model

On completion of the cavity preparation, a model of the proposed inlay is carved in wax. Special waxes used for this purpose are Taggart's, Kerr's, and Ransom and Randolph's Standard. For obtaining the model, heat the wax in water at a temperature of 138°F. Mold into a cone (working between the thumb and fingers until plastic), and force into the cavity until overfull and perfectly adapted to the walls. Use a lubricant in the cavity if necessary, such as olive oil or liquid paraffin, to facilitate easy withdrawal. Have the patient bite into the wax and chew on it, to obtain the proper occlusal form. Then trim off excess from the occlusal surface, and carve to proper contour on approximal surfaces, with Taggart's, Roache's or other inlay carvers (Fig. 249) until smooth, after which put on a higher finish with chloroform. After completion of



FIG. 249.
—Inlay
carver.

the model it should be chilled in cold water before removal (see Figs. 250, 251, 252 and 253). In cases of badly broken down teeth the obtaining of the wax pattern may often be



FIG. 250.—Wax models carved and ready for removal.



FIG. 251.—Wax model ready for insertion of sprue wire.

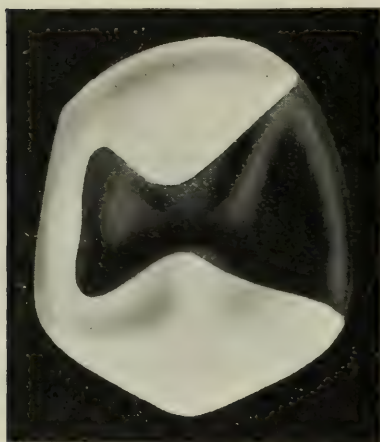


FIG. 252.—Wax model ready for withdrawal.

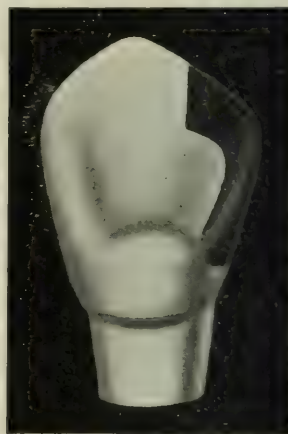


FIG. 253.—Wax model ready for insertion of sprue wire.

facilitated by the use of a matrix band encircling the tooth, to hold the wax in position during its adaptation.

Construction of the Inlay

After the wax model is carved, chill it, heat and attach the sprue wire, in a part of the wax affording sufficient bulk

and admitting proper "draw," and carefully remove from the cavity; or remove with an explorer and attach the sprue wire afterwards. The spure used may be a banker's pin, phonograph needle, or copper wire. After washing in alcohol, place the model in the crucible former (Fig. 254) with the sprue wire protruding through the opening, and gently cover the wax, by means of a camel's hair brush, with a thin batter of investment material, such as Taggart's, Imperial, or other finely ground investment. Apply the casting flask, round edge down, gently fill with investment, and allow to set for 15 minutes. Now carefully remove the crucible former and sprue, and heat slowly at low temperature for from 1 to 2 hr. to burn out the wax; then melt a button of 24 karat gold and force into the mold with the casting machine, after which, remove from the investment, pickle in 50 per cent. solution sulphuric acid, polish roughly, cement into the cavity, burnish the margins and finish in the mouth. Among the various forms of casting machines in use today may be mentioned the Taggart, the Jamieson, the Price and the Elgin (Fig. 255). These machines act on the principles of either centrifugal force, suction, or pressure. Instead of making the wax model in the mouth, some operators prefer the **indirect method**, as follows:

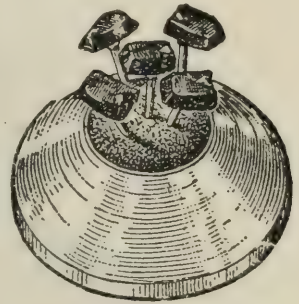


FIG. 254.—Five wax models in crucible former, ready for investments.

Take an impression of the cavity with Detroit impression compound, imbed in plaster with the impression side up, obtain from this a model in amalgam, into which, after it has hardened, a wax pattern of the proposed inlay is adapted, after which the procedures are the same as in the direct method. If desired, a bite may also be obtained at the time the impression of the cavity is taken, and the case mounted

on the articulator, in order that more exactness as to carving of the occlusal form of the wax model may be obtained. The principal advantage in the indirect method is the time saved at the chair.

In the construction of the gold inlay, most of the errors arising and misfits resulting are due to differences in the ratio of expansion and contraction of the wax model, the investment, and the gold at the different temperatures at which they are handled. The secret of success in this regard

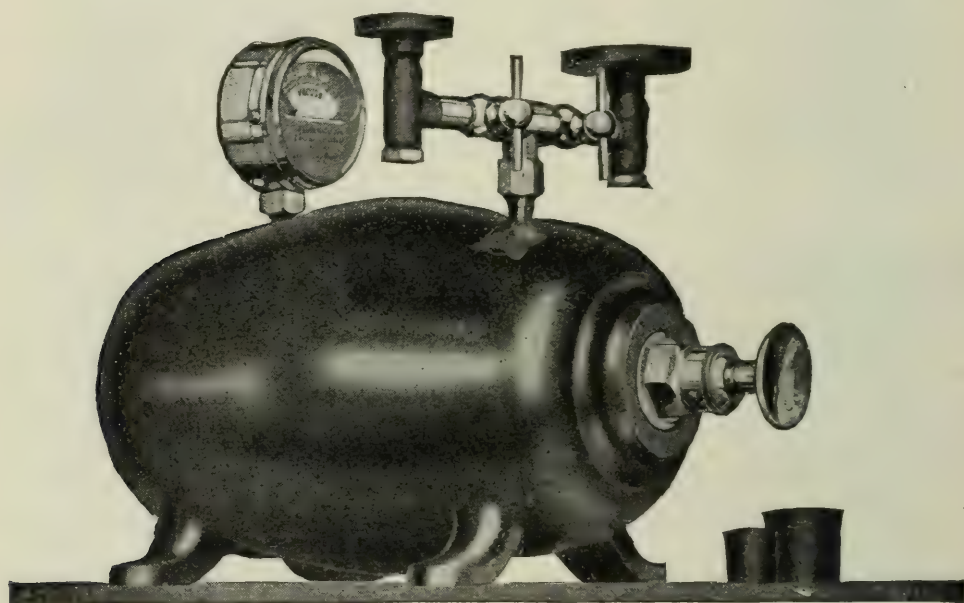


FIG. 255.—Elgin casting machine.

is to keep these materials at as nearly the same temperature as conditions will admit, throughout the process of construction. The wax should be allowed to assume room temperature before investing. The water used in mixing the investment should not be obtained direct from the water spigot, either hot or cold, but should be kept in a bottle at room temperature, ready for use. The investment should not be too hot at the time the gold is cast. There is no advantage whatever in a very hot investment, the disadvantages being

change of form and tendency to destroy fine lines, as a result of the heat applied. Neither should the gold be heated to too high a temperature before casting, this also resulting in increased tendency to shrinkage on cooling. If these brief details are followed, much better results will be obtained in the fitting of inlays than otherwise.

TECHNICAL EXERCISES

1. Prepare eight cavities of various types in extracted teeth for metal inlay work.
2. Make wax models, invest, cast inlays in acolite or an alloy of silver and copper, set and polish.

THE PORCELAIN INLAY

Cavity Preparation.—Cavity preparation for the porcelain inlay requires certain modifications of the types shown and described in the section on the gold inlay. The principal features of the cavities designed for the reception of this material are as follows, viz.:

Adequate *access* is a necessity, either by cutting or separation, or both, to allow for withdrawal of the matrix. The *outline form* should not follow a developmental groove, or cross a ridge at its highest point. Owing to friability of the material, margins should be extended to points least susceptible to crushing stress. The outline form should never be circular, else difficulty may be experienced in seating the inlay into its proper position, after fusing (Fig. 256). Adequate *resistance form* is a necessity, and maximum *retention form* is required in all directions, except one, until the inlay is completed, when retention should then be added in the remaining direction, by cutting the cavity walls. All line and point angles should be rounded, until the matrix is completed,

when they should then be deepened for retention. Surrounding walls should meet the basal wall or seat at an obtuse angle to admit the ready withdrawal of the matrix. Retention may be increased by pins, more generous step forms than for gold, double steps, extension of porcelain into pulp chambers, and similar measures. The *cavo-surface angle* should be a right angle, or if a bevel angle exists, it should be deeply buried to afford strength to the porcelain. The cavity should be washed, first with chloroform to dissolve fatty matters, then with alcohol; and thoroughly dried before setting the inlay.

COMPOSITION AND GENERAL CHARACTERISTICS OF PORCELAIN

The general composition of Porcelain for inlays is as follows: First, *Basal ingredients*, such as Silex, Kaolin, Feldspar; Second, *Fluxes*, such as borax, sodium carbonate and calcium phosphate; and third, *Pigments*, such as gold, platinum, purple of Cassius, oxide of Cobalt, Titanium, Iron, Uranium and Silver.

There are two general classes of porcelain used in inlay construction, viz.; high and low fusing.

High fusing porcelain requires 5 minutes or more to fuse at a temperature exceeding the fusing point of gold (2,012°F.), while low fusing porcelain requires less than 5 minutes.

A porcelain inlay usually requires several bakings in the furnace. The first of these bakings is known as the biscuit fuse. By the biscuit fuse is meant the act of heating the porcelain sufficient to obtain shrinkage, but not enough to glaze it. The first bake should never exceed a low biscuit fuse, subsequent bakes being fused to a higher temperature, but the final glaze being not completed until the last bake.

High fusing porcelains shrink 15 to 25 per cent. of their volume, while low fusing bodies contract from 20 to 35 per cent. during the baking process.

The advantages claimed for the porcelain inlay are harmonious color and non-conductivity, while its *disadvantages* are friability, difficult manipulation, the presence of the cement line and impossibility to preserve freshly cut cavity walls during its construction.

Following is a list of the prominent porcelain bodies on the market with their fusing points.

Whiteley's.....	2,300°F.
S. S. White Dental Mfg. Co.....	2,300°F.
Consolidated Dental Mfg. Co.....	2,600°F.
Johnson & Lund.....	2,550°F.
Ash & Son.....	1,900°F.
Jenkins.....	1,550°F.

The two latter may be considered low fusing bodies.

Obtaining the Matrix.—Platinum foil, 0.001 of an inch in thickness for high fusing, and pure gold or platinized gold for low fusing porcelain are used for this purpose. The platinum foil may also be used for low fusing work.

For obtaining the matrix, first anneal the material in the electric furnace, carrying gold or platinized gold to full red heat (1,200 to 1,300°F.), and platinum to a dull yellow color; then follow one or a combination of the three following METHODS, viz.:

1. *Burnish Directly into the Cavity.*—Cut the foil into proper size and shape (Fig. 256), allowing sufficient excess to extend one-fourth to one millimeter beyond the margins of the cavity, except that in one location it may extend 2 or 3 mm. for convenience in handling. Force the matrix carefully into the cavity (beginning at the seat of the cavity first, avoiding tearing and crumpling) by means of small pieces of spunk or chamois discs and smooth burnishers. Now,

after removing the spunk or chamois, pack the cavity with damp cotton balls, crowding the matrix to every part of the cavity, and then thoroughly burnish the margins while the cavity is full. Now remove the cotton, and pack the cavity nearly full with camphor or inlay wax, with a large burnisher, to complete the adaptation. Next, carefully remove the matrix, by means of an explorer, then immerse in alcohol to soften the camphor, or in chloroform to soften the wax. Then grasping the edges of the matrix in a pair of locking pliers, pass it through the flame to melt out the remaining wax or camphor.

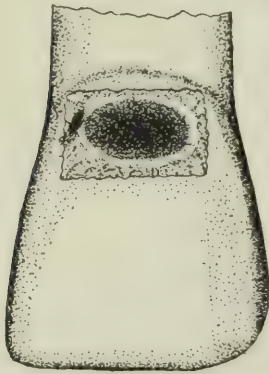


FIG. 256.—Securing the matrix by burnishing into the cavity.

2. *Take an impression of the cavity* in modeling compound, trimming away excess of the compound from the margins. Adapt the matrix over this with the thumb and fingers, and then force the matrix and compound into the cavity. Peel the edges of the matrix away from the modeling compound and remove the compound, leaving the matrix in the cavity, when the balance of the procedures, as already outlined, may be followed. In some cases a soft pine stick may first be forced into the cavity, to obtain an outline of the cavity, and the matrix then adapted over that, and later fitted to the cavity, as previously described.

3. *Make a model of the cavity*, in amalgam or cement, from a modeling compound impression, and adapt the matrix to this, completing the burnishing in the mouth.

Mixing and Fusing the Porcelain.—The process of mixing and fusing the porcelain is as follows:

Mix to a creamy consistency, on a clean glass slab, by means of a clean spatula, with distilled water. Some use alcohol for this purpose. Select the proper shades, with the shade guide

provided for this purpose. Lay on the body, and fuse in the furnace, in layers, to a biscuit bake, jolting the material into the matrix, and absorbing excess moisture on blotting paper, before placing in the furnace. In complex cavities, when the teeth vary in color at the cervix and cutting edge, build the body in sections instead of layers. Continue adding the body and partially fusing until the matrix is nearly full, when the last layers of enamel may be added, carved to

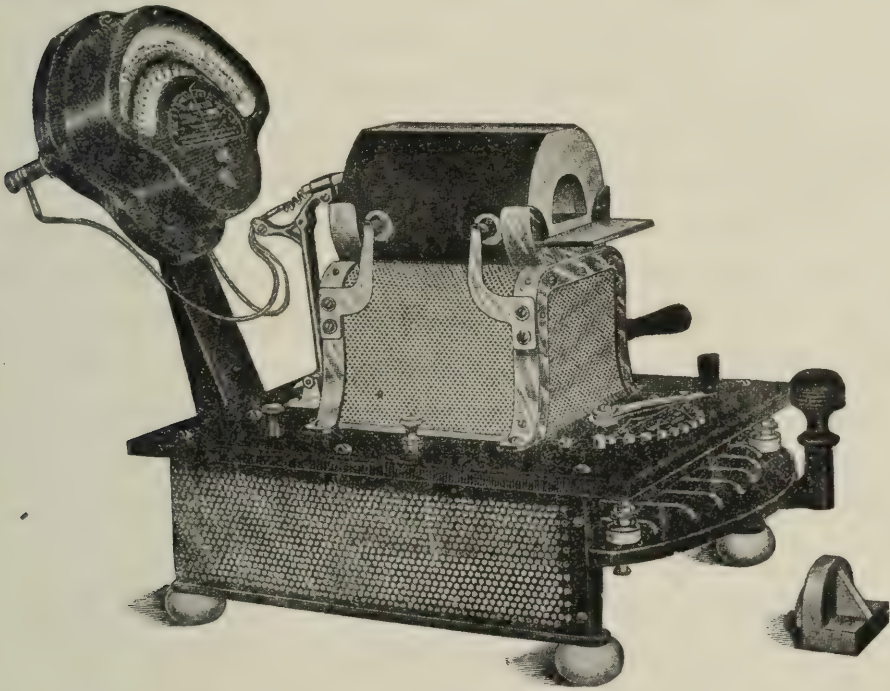


FIG. 257.—S. S. White electric furnace.

form with an inlay cover (Fig. 249) and brought to a full glaze. With low fusing porcelain and gold matrices, the case may be invested, to prevent warping. With platinum matrices, this is not necessary. Avoid putting the porcelain, when wet, into a hot furnace (Fig. 257) on account of the danger of producing checks in the porcelain. A small tear in the matrix, provided it is not on the margin, will do no damage, as the porcelain, if it runs through, may be removed

with a fine brush before fusing. All excess porcelain should also be removed from the margins, with a brush, before fusing. The baking should be continued until proper contours are restored, trying in the mouth as often as is necessary to accomplish the result. After the final fusing, try the inlay in the mouth, and before removing the matrix, grind to the proper contour and occlusion with a fine stone. Now carefully remove the matrix. This is accomplished by dropping the inlay and matrix in alcohol or water, then carefully peeling the matrix away, first from the margin and later from the body, to prevent chipping of the margins.

The under surface of the inlay should now be etched to provide for better retention. Imbed the contour surface of the inlay in wax, and seal the margins with a hot spatula to prevent contact of acid with the margins. Dip a sharp wood stick into the wax bottle containing hydrofluoric acid and paint the exposed side of the inlay with the acid for 2 or 3 minutes, thus etching or roughening the inlay, to provide for a better grasp of the cement. Then flood with water, remove the wax, wash with boiling water followed by chloroform, then dry, when the inlay is now ready to set.

After thoroughly drying the cavity and inlay, cover the walls of the cavity and the under surface of the inlay with a good, white, sticky cement, mixed to a creamy consistency. Press the inlay firmly to place with an orange wood stick, tapping until firmly seated, when it should be held or wedged to place until the cement is set. Finish down at a subsequent sitting, removing excess cement, dressing down over-hanging margins, and polishing with fine stones and discs.

CHAPTER VIII

THE TREATMENT OF PULPS AND THE OPENING AND FILLING OF PULP CHAMBERS AND CANALS

General Considerations.—The pulp is situated in the pulp chamber and canals, which it completely fills. It sends out numerous prolongations, the **dentinal fibrillæ**, which penetrate the dentin to the **dento-enamel junction**, and in some cases enter the enamel. The enamel is a low conductor and acts as a **protective covering** to the pulp and the dentinal fibrillæ, preventing the contact with and the transmission of sensations of heat and cold, electricity, and chemical substances. When the enamel is intact and the pulp healthy, the tooth is **not sensitive** to ordinary variations in temperature, the application of a mild electric current, or the presence of the chemical substances usually found in the mouth, such as sweets and acids. If, however, through the action of decay or other causes, the enamel be lost and the dentinal fibrillæ be subjected to the action of these agents, they soon become **abnormally responsive** to them, transmitting these sensations to the pulp, which soon becomes irritated, and a **diseased condition** of its substance supervenes.

1. **If the condition receive early treatment**, the resultant fulness in the arteries of the pulp (**Arterial Hyperæmia**) be relieved and the lost enamel and dentin be compensated for, by the application of a non-conducting filling, *the pulp may be permanently restored to its normal condition.*

2. **If allowed to continue**, the increased supply of blood in the arterial system of the pulp is dammed back into the veins (**Venous Hyperæmia**) and this condition supervening, finally

results, on account of the pressure produced in the vessels, in the passage of a portion of the blood into the interstices of the pulp tissue, with the result that a condition of **Inflammation** is established. When Venous Hyperæmia or Inflammation is present, *the only alternative is the destruction and removal of the pulp.*

3. **If the condition be still further neglected**, germs, constantly present in the mouth, make their entrance into the pulp tissue, with the result that pus formation occurs (**Suppuration**), or the death of the pulp is finally accomplished through a process of putrefaction, with the formation of malodorous gases (**Putrefactive Decomposition** or **Moist Gangrene**). If, however, germs do not enter, the pulp will die a natural death from lack of nourishment (its blood supply being interfered with) and the condition of **Dry Gangrene** is established.

4. **If these latter conditions supervene**, there is then always the possibility of the pathological condition extending through the apical foramen, with the resultant production of disease processes in the tissues of the apical space, and the formation of an **Alveolar Abscess**.

The diseases of the pulp mentioned above are **progressive** in character and may be briefly described as follows:

1. **Arterial Hyperæmia**.—An increased supply of blood in the arteries of the pulp, resulting in over-fullness and distention of these vessels, with consequent pressure on the nerves and resultant pain.

2. **Venous Hyperæmia**.—The blood is dammed back into the veins, with the production of the same conditions in these vessels, increased pain from pressure, and passage of lymph and red corpuscles into the interstices of the pulp.

3. **Inflammation**.—The pressure in veins and arteries results, in addition to the preceding complications; in the passage

of the white corpuscles through their walls into the interstices of the pulp tissue.

4. **Suppuration.**—The corpuscles and the surrounding pulp tissue are broken down and transformed into pus, through the action of germs, which have entered by way of the blood stream.

5. **Moist Gangrene.**—(Putrefaction.) The blood current becomes stagnant and finally ceases, on account of the pressure in the vessels passing through the minute apical foramen. Death of the tissues occurs from lack of nourishment, putrefactive decomposition and destruction occurring through the action of germs, with the formation of malodorous substances.

6. **Dry Gangrene.**—Germs do not enter, death of the tissues occurring without suppuration or putrefaction, from strangulation and lack of nourishment.

7. **Alveolar Abscess.**—The putrescent material infects the tissues of the apical space, with resultant pus formation, breaking down and destruction of these parts.

The above conditions may be **classified** as follows, viz.:

1. **Vital Pulps.**

(A) Pulps capable of being restored to the normal (Arterial Hyperæmia).

(B) Pulps incapable of being re-
stored to the normal. $\left\{ \begin{array}{l} \text{(Venous Hyperæmia)} \\ \text{(Inflammation)} \\ \text{(Suppuration)} \end{array} \right.$

2. **De-Vital Pulps.** (Non-vital.)

(A) Pulps uninfected. (Dry Gangrene.)

(B) Pulps in a state of putrefaction and infection. (Moist Gangrene.)

(C) Pulps with apical complications. (Alveolar Abscess.)

Avoidance of Pressure.—In cases of **exposure** (a minute opening through the wall of the pulp-chamber), the vital pulp rebels against the application at the point of exposure of the

slightest amount of pressure, so that during the treatment of these conditions, great **delicacy of touch** and the absolute avoidance of pressure is essential.

Adoption of Aseptic Precautions.—Owing to the fact that the saliva and the decay present in cavities are highly infected

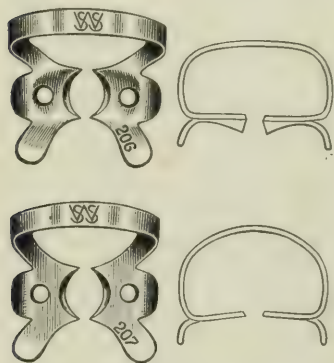


FIG. 258.—Bicuspid rubber dam clamps.

with **germs**, whenever an exposure of the pulp occurs, these germs enter the pulp chamber and infect the pulp tissue, producing what is known as a **Septic condition**. The pulp is infected, then, in all cases of pulp exposure, and there is also a possibility of these germs entering to the pulp through thin layers of dentin in the floor of cavities, by way of the dentinal tubules, even in those

cases in which the pulp is not exposed. In the conditions of Suppuration and Moist Gangrene, highly infective microorganisms are always present. This being the case, it becomes necessary in treating these conditions in the mouth to adopt measures to prevent, as far as possible, the entrance of these germs, by absolutely and permanently **excluding the saliva** from the cavity; or, in case the germs are already present, to destroy them by the application of certain drugs known as **Antiseptics** and **Germicides**, which will either inhibit their further growth or totally destroy them. These measures are known as **Aseptic Pre-**



FIG. 259.—Bicuspid rubber dam clamps.

cautions, because they prevent or relieve the septic condition, and consist of the *application of the rubber dam in all cases* (Figs. 258, 259, also see Figs. 115 and 116), and the *use of antiseptics* on the tissues being operated upon, as well as on the instruments used.

(I) TREATMENT OF VITAL PULPS

(A) **Pulps Capable of being Restored to the Normal.**—

The treatment is known as **Conservative** treatment, and depends on whether the decay, when present, has extended to the pulp chamber, constituting the condition known as **Exposure of the Pulp**, or whether it has not produced this condition. If the pulp be not exposed, the treatment applied is known as **Pulp Protection**; if the pulp be exposed, the operation of **Pulp Capping** may be resorted to.

1. **Pulp Protection.**—(a) Under “aseptic precautions,” establish the outline form of the cavity, remove the decay, make slight retentive form, and seal into the cavity with base plate gutta percha or cement, a small pledget of cotton moistened with an **antiseptic** and **anodyne** (pain reliever), such as eugenol or oil of cloves. (b) At the end of 24 or 48 hours, if pain is relieved, remove the dressing under “aseptic precautions,” varnish the cavity walls, place a cement intermediate in position and fill.

2. **Pulp Capping.**—The indications for the operation are accidental exposures, teeth with incompletely formed roots, and very badly broken down teeth, otherwise impossible to save. In all of these, the condition of the pulp must not have passed beyond the stage of artereal hyperæmia, since it is usually impossible to restore pulps to a normal condition which have progressed beyond this stage.

A thin paste composed of one of the following substances or mixtures may be used for capping pulps.

1. Thymolized calcium phosphate and clove oil, eugenol or phenol compound (Buckley).

2. Zinc oxide and clove oil.

3. Chloro-percha.

4. Paraffine (melted), or paraffine and salol.

5. Zinc oxy-sulphate cement.

6. Jodo-formagen cement (composition, phenol, eugenol, formaldehyde and iodine salts).

Of these, the author usually prefers the first two mentioned.

1. Spray the mouth with an antiseptic, apply the rubber dam and flood the cavity with an antiseptic.

R. Phenolis..... ʒi
 Aquæ menthæ piperitæ..... ʒvi
 Misce. Sig. Use wherever a mild, non-irritating antiseptic is indicated. (*Buckley.*)

2. Establish the outline form and remove the decay.

3. Seal into the cavity for a week, an anodyne, antiseptic preparation, for relief of hyperæmia, pain and irritation. Phenol compound (*Buckley*), eugenol, clove oil, campho-phenique and Black's 1-2-3 are all recommended.

The formula of phenol compound is as follows:

Menthol..... gr. xx
 Thymol..... gr. xl
 Phenol (U. S. P.)..... ʒiii

Heat the phenol and carefully add the others. (*Buckley.*)

4. Tease over the point of exposure and floor of the cavity, without pressure, a small amount of the capping material, mixed to a creamy consistence; cover, and fill the cavity with a creamy mix of oxy-phosphate of zinc cement, and allow to remain for 6 months to a year, when, if the pulp has remained quiet, the outer layer may be removed and a permanent filling inserted. Some operators prefer to carry the capping material to, and hold it over the exposure, with a concavo-convex metal disk of gold, platinum or german silver, in order to avoid pressure. The cap may be obtained ready prepared, or it may be cut and swaged on a soft block of wood to the proper shape and size. In the majority of instances it is not necessary.

(B) **Pulps Incapable of Restoration to the Normal.**—The treatment is known as **Radical** treatment and consists in the adoption of one or the other of the following procedures, *viz.*,

(1) Devitalization.

(2) Anesthetization.

(1) **Devitalization.**

Technic.—(a) Under aseptic precautions establish the outline form, remove the decay and make the cavity slightly retentive, avoiding pressure on the pulp. (b) **If the pulp is aching**, place gently over the exposure a pledget of cotton saturated with an **anodyne**, such as eugenol or clove oil, and seal (avoiding pressure) with base plate gutta percha or cement, allowing it to remain for from 24 to 48 hours. (c) Remove the dressing under aseptic precautions, and gently place directly over the exposure, or slightly to one side, with a pair of dressing pliers, a small pledget of cotton or piece of asbestos, on which has been placed a minute amount of **arsenical paste**. (d) Seal, avoiding pressure, with gutta percha or cement, and allow to remain from one to seven days (usually two days), at the end of which time the vitality of the pulp is destroyed, and it may be painlessly removed.

Arsenical Paste is a mixture of arsenic trioxid with cocaine or novacaine hydrochlorid and other drugs for the relief of pain. The arsenic trioxid gradually produces death of the pulp through a **process of inflammation**, finally causing **strangulation** of the vessels by cutting off the blood supply at the apical foramen. Its action is usually painful, hence its combination with cocaine and other pain-alleviating drugs. If the minutest amount of **arsenic trioxid escapes** from the cavity and comes in contact with the gums, it will produce inflammation and death of these parts (**arsenical poisoning**), which is liable to extend to the bony tissues, hence great care must be observed in placing arsenical dressings to see that

they are **perfectly sealed**. The tendency in modern practice is to abandon the devitalization method on account of its slowness and the dangers involved.

(2) **Anesthetization.** (Pressure anesthesia.)

Novocaine hydrochlorid has the property of temporarily depriving the tissues of sensation. When forced into the tissues of the pulp, that organ is for a time **anesthetized**, when it may be painlessly removed.

Technic.—(a) and (b) Perform the same procedures as described under the same headings for “devitalization.” (c) Place a small piece of novocaine hydrochlorid in the bottom of the cavity, and after adding a drop of sterile water, when it will be dissolved, cover it with a pledget of cotton. (d) Cut a piece of soft, unvulcanized rubber of a size sufficient to fill the cavity, and with a large amalgam plugger or smooth burnisher, slowly and gradually **apply pressure**, thus forcing the novocaine solution into the pulp, constantly maintaining pressure until it does not elicit pain, when the rubber and cotton are removed and the pulp is ready for **extirpation** (removal). The rubber is placed so that it acts as a washer and prevents the backward flow of the novocaine solution.

Sterilization of the cavity before pulp removal is important, because it is necessary to avoid infecting the pulp and apical tissues during the subsequent procedures. In addition to the application of the dam and sterilizing agents, all instruments and appliances should be sterilized. Coagulating agents, such as phenol, should be avoided for sterilizing cavities, preceding the operation. Use for the purpose a 10 per cent solution of formalin, 1 to 500 solution of mercuric chlorid, 25 per cent solution of sulphuric acid, or sodium dioxid. Grieves has recently recommended for this purpose one part beechwood creosote in ten parts clove oil, sealed into the cavity for 2 or 3 days preceding the operation.

(2) TREATMENT OF DE-VITAL PULPS

(A) **Pulps Uninfected (Dry Gangrene).**—The pulp has not been exposed to external influences, hence is not infected and consequently remains in the sound, undecayed tooth, or under an old filling, in a **dry, shrivelled condition**. The treatment consists in its removal under aseptic precautions, with immediate root filling, or the sealing in the canals for two or three days, of cotton containing a bland **antiseptic**, such as phenol compound or 5 per cent solution of formalin, after which they are ready for filling.

(B) **Pulps in a State of Putrefaction (Moist Gangrene).**—A large number of **germs** are present, the pulp tissue is rapidly being transformed into a putrefying mass and gases of a disagreeable odor are being formed, through the process of **putrefactive decomposition**, all of this constituting a highly septic condition. The treatment consists in the application, under aseptic precautions, of agents which will destroy the germs (**antiseptics and germicides**), and chemically transform the putrefactive material and gases into *harmless substances*.

Technic.—(a) Under aseptic precautions, establish the outline form, remove the decay, and make the cavity retentive. (b) Open the pulp chamber and remove the **bulbous** portion of the pulp. (c) Seal in the pulp chamber, by means of base plate gutta percha or cement, on a pledget of cotton, a mixture of equal parts of formalin and cresol, known as **formo-cresol**. (d) At the end of from 24 to 72 hours, take out the dressing under aseptic precautions, and remove the remainder of the pulp **from the canals**. (e) Place *in each canal*, and also in the pulp chamber, cotton containing the formo-cresol mixture, and seal the cavity as before. (f) After an interval of from 24 to 72 hours, remove the dressings under aseptic precautions and, if all evidences of putrefaction have disappeared, fill.

Another method of treating putrescent pulps is through the use of sodium dioxid.

Sodium dioxid, Na_2O_2 , introduced by E. C. Kirk in 1893, is a yellowish white powder, containing a large amount of oxygen, on which it depends for its efficacy. It must be handled very carefully, on account of the danger of an explosion, if brought near a flame or mixed carelessly with water. It is a strong caustic, hence, the importance of preventing contact with the soft tissues. It is better handled with gold, platinum or glass instruments, on account of its corroding action on steel. The tooth should be isolated with a rubber dam and carefully ligated, the use of steel clamps being avoided on the tooth to be treated. A paste may be made by mixing the preparation with chloroform on a glass slab, to be carried into the pulp chamber and canals on broaches, preferably of gold or platinum; or a small amount of the powder may be laid on the glass slab and a few drops of water placed to one side. Then the broach may be moistened in the water, drawn quickly through the powder and instantly carried into the canals, when effervescence ensues, due to the oxidizing and destructive effect of the preparation on the organic contents. The procedure is repeated until all of the pulp tissue is burned out and the canals cleansed of their contents. Avoid forcing the preparation through the apex, on account of its caustic and irritating effects. In addition to saponification of the gangrenous pulp tissue and its detergent effect, bleaching of the tooth is accomplished. The preparation also, owing to its softening effect on the walls of canals, is valuable in enlarging small canals. In some instances, the canals may be filled at once. In other cases an anodyne antiseptic dressing, or hydrogen-dioxid, may be sealed in position and the sodium dioxid treatment repeated at a subsequent visit, if found necessary.

(C) Pulps with Apical Complications (Alveolar Abscess.)

—The putrefying material and the germs have been forced by the expansion of the gases being formed, through the apical foramen into the tissues of the **apical space**. The treatment, in addition to that outlined above, consists in the application of measures to relieve the conditions at the end of the root, which will not be considered at this time, but will be reserved for a subsequent chapter.

Technical Exercises

1. Surround the apices of the roots of the teeth on which the pulp treatments and the exercises in canal work are to be performed with wax, to simulate the tissues of the apical space. Mount the teeth in plaster of Paris, molding and carving it to a convenient size and shape for handling.

2. Establish the outline form of the cavities, remove the decay and render slightly retentive, exposing the pulps, if not already exposed.

3. Seal antiseptic and anodyne treatments in several teeth.

4. Perform the operation of pulp capping on several teeth.

5. Perform the operations of arsenical devitalization and pressure anesthesia on others.

OPENING PULP CHAMBERS AND CANALS

One or the other of the following conditions will be present.

1. The pulp has been previously **anesthetized** with novocaine or **devitalized** with arsenic.

2. The pulp is devital and uninfected; or in a state of **putrescence** and infected with germs.

Rule 1.—**When cavities are present**, make the approach to the pulp chamber through the cavity.

Rule 2.—In sound teeth, or teeth with perfect fillings, enter through the center of the lingual surface of incisors and cuspids, the mesial pit of bicuspids and the central fossa of molars.

Rule 3.—Enlarge the opening, whether through an already existing cavity or one artificially made, until **convenient access** to the pulp chamber and canals is obtained; at the same time, *avoid weakening the tooth* by too much cutting.

Rule 4.—Make the **walls of the cavity and pulp chamber** *continuous and smooth*, though not necessarily parallel or on the same plane.

Rule 5.—Make the **walls of the pulp chamber and canals** continuous and smooth.

Technic for Opening into Pulp Chambers

I. In Sound Teeth.

(a) **Perforate the enamel** with a 1-millimeter bi-bevelled dentate fissure bur (made by bevelling a dentate fissure bur on two sides), or a small spear-point drill, in the handpiece of the engine.

(b) **Enlarge the opening** with a larger sized bur or drill.

(c) **Perforate the dentin** gradually to the pulp chamber, alternating first with the smaller and then the larger sized burs or drills, avoiding the **danger of breakage** by frequently withdrawing, and continuing in this manner until the pulp chamber is reached.

(d) **Enlarge the opening** with the same instruments until convenient access is obtained, and then remove the entire wall of the pulp chamber, extending the cuttings out until the **horns** of the pulp chamber are included.

(e) Make the walls of the cavity and pulp chamber **continuous and smooth**.

(f) Remove the **contents of the pulp chamber** and all débris (Figs. 260, 261, 262 and 263).

2. Through Cavities of Decay.

(a) Establish the outline form, remove all decay, and make the cavity slightly retentive.

(b) If the pulp is not exposed, penetrate the dentin to the pulp chamber, with the drills or the bi-bevelled dentate fissure bur.

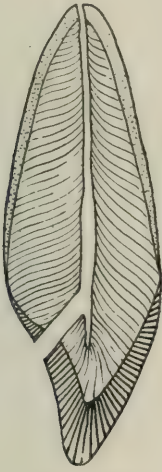


FIG. 260.

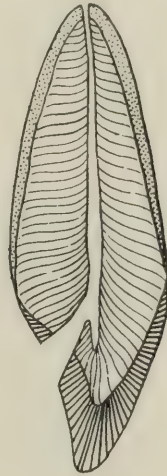


FIG. 261.

FIG. 260.—Series of illustrations showing the method of opening into the pulp chamber and canal through the lingual surface of the anterior teeth.

First drill through the enamel and dentin until the pulp chamber is reached; then gradually enlarge the opening with burs or drills of increasing diameter.

FIG. 261.—Then increase the size of the entrance by inclining the shaft of the fissure bur first toward the gingival and then toward the incisal portions.

(c) **Remove the wall of the pulp chamber** with a hoe excavator or a dentate fissure bur, extending the cuttings until the *horns of the chamber are included*.

(d) In incisors and cuspids **straighten the approach** to the canal by extending the cavity in the lingual or gingival direction with a dentate fissure bur. (See Figs. 260 to 263.)

(e) In upper molars, **straighten the approach** to the mesio-buccal canal by extending the cavity with a fissure bur toward the mesio-buccal cusp, and enlarging the pulp chamber

in the same direction by means of the same instrument or a cleoid excavator.

(f) Make the walls of the **cavity and pulp chamber** continuous and smooth.

(g) Remove all debris.

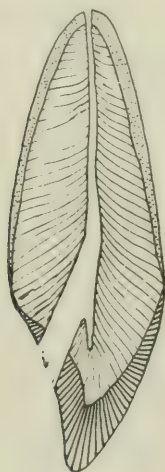


FIG. 262.

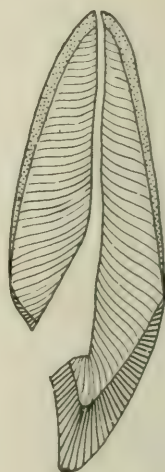


FIG. 263.

FIG. 262.—Straighten the approach to the canal on the lingual side by means of the fissure bur. The passage of a small broach to the apex has thus been rendered easy by the removal of the small shoulder at the entrance to the same shown in the preceding illustration.

FIG. 263.—Place the dentate fissure bur in position and open the chamber to its incisal extremity, thus removing the horns of the pulp chamber with their contents. The walls of the cavity, pulp chamber and canal are now continuous and smooth.

Technic for Opening into Canals

There is no operation in the entire field of dentistry or surgery, which requires greater skill than that of the proper opening and filling of root canals. There is none which has a more far-reaching influence on the future health and well-being of the patient. The non-removal of pulp remnants, the imperfect opening, enlarging and sterilization of the canal to the apex, or the failure to hermetically seal it for its entire length, results in the leaving of an inviting field for the continuance or establishment of the septic condition, which may later undermine the health and produce even death of the

patient, through the absorption of toxic products into the system by way of the lymphatics and blood streams in the tissues of the apical space. (See Figs. 264, 265, 266, 267, 268 and 269.) A full discussion of this phase of the subject is deferred until a subsequent chapter. However, it is deemed wise to mention it here, in order that the importance of a thorough realization of the bearing of the operation on general health conditions may be at once clearly perceived.

Pulpless teeth with anomalous roots impossible to properly treat and fill should be extracted without hesitation. Teeth



FIG. 264.—Imperfectly opened or unfilled canals in the upper central and lateral incisors.



FIG. 265.—Canals not opened and filled in the mesial root of the lower molar.

affected with incurable pathologic disturbances in the canals or apical space should be unhesitatingly removed. The possibility of the existence of an excessive number of roots, as well as concealed root canals, should constantly be borne in mind, and redoubled care exercised in an attempt to discover an opening. It should also be remembered that the majority of roots exhibit more than one apical foramen, oftentimes many minute accessory canals in the apical third, or even in the mid-root being present. These are, in the present state of development of our technical skill, impossible

to fill. However, a realization of these anatomical conditions should redouble the painstaking care exercised in canal sterilizing and filling procedures.

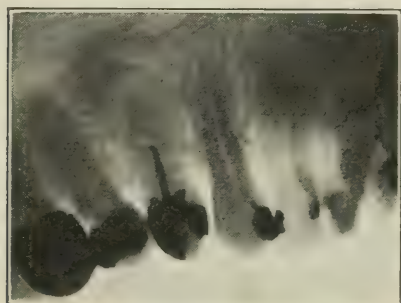


FIG. 266.—Canal imperfectly opened and filled in a bicuspid.



FIG. 267.—Poor canal operation in the second bicuspid.

The introduction of the X-ray has resulted in great improvement in the methods of diagnosis and treatment of these conditions. All roots which are to be treated and filled should be subjected to the Roentgen ray at the beginning, and at



FIG. 268.—Imperfect canal operations in the upper central and lateral.

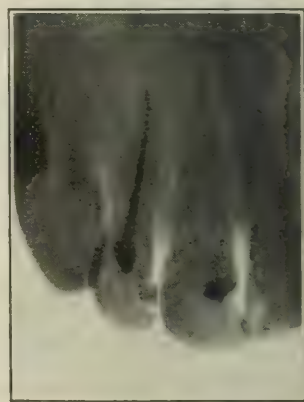


FIG. 269.—A good canal filling, radiographed immediately after completion.

frequent intervals during the progress of the various procedures, as well as at the completion of the root filling operation, in order that the progress of the work may be revealed and the final results shown.

After exploration, opening and enlarging of the canals, diagnostic wires should be inserted to the end of each root canal (Figs. 270 and 271), and an X-ray taken, to make sure that the results desired have been obtained. If the radiograph indicates that the canals have not been opened to their extremities, additional work is then required to accomplish the result, at the termination of which the diagnostic wires are again applied and the tooth subjected to the X-ray a second time, to note the result. As diagnostic wires, old



FIG. 270.—Diagnostic wires in position.

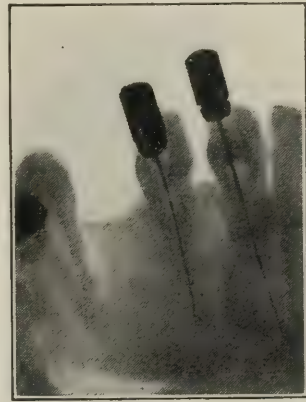


FIG. 271.—Diagnostic wires carried too far.

smooth broaches may be cut to convenient length and used, or strands of small braided picture wire may be substituted.

The **anterior teeth**, both upper and lower, have one root canal which is continuous with the pulp chambers, and as a rule easily found after the approach has been straightened, as already described. The **upper first bicuspid**s have, in the majority of instances, two canals, one buccal and one lingual, although in probably one-third of the cases, only one canal is present. The **upper second** and the lower bicuspid present as a rule a single canal. In the **upper molars** there are present three canals, a mesio-buccal, disto-buccal, and lingual, placed at the *angles of a triangle* (molar triangle). The **lower molars**

have a mesio-buccal and a mesio-lingual canal, located in the mesial root and a distal canal situated in the distal root. The canals in the lower bicuspid are more or less continuous with the pulp chambers, while those in the upper bicuspid and the upper and lower molars are separate and distinct from the chamber, opening from its floor with more or less **constricted orifices**. Owing to the presence of these constrictions, and the small size of the buccal canals in the upper molars and



FIG. 272.

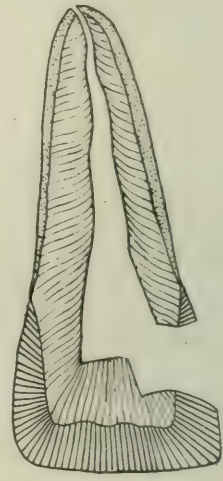


FIG. 273.

FIG. 272.—Cavity of decay on the mesial surface of a central incisor opening into the pulp chamber. It would be difficult to pass a broach to the apex owing to the shoulders on the mesial side of the entrance to the canal.

FIG. 273.—Straighten the approach to the canal by enlarging its entrance on the mesial side with a dentate fissure bur, a Kerr tapered canal reamer or a spiral broach reamer. Then enlarge the cavity toward the incisal and remove the horns of the pulp chamber. The cavity, chamber and canal are now continuous and smooth.

the mesial canals in the lowers, difficulty is frequently experienced in locating their entrances and following them with instruments to their termination.

Technic.—(a) **Locate** the entrance and **explore** the canals with a small, round, smooth broach.

(b) **Enlarge the orifice** with a Kerr or Downie tapered canal reamer, a small bud-shaped bur, a twist broach, spiral broach reamer, or a Donaldson canal cleanser (Figs. 272 and 273).

(c) Make the walls of the pulp chamber and canals **continuous**.

(d) **Pass a small canal cleaner** to the apex, or until it binds, withdraw slightly, give it a half turn and then remove from the canal, bringing away as much of the pulp tissue as possible. Continue this, using larger and larger sizes, as the canal will permit, broaching or **rasping** the sides of the canals, and gradually enlarging them. **Carry the broach just to the apex, and no further.** The passage of the broach through the apical foramen will produce irritation in the tissues of the apical space, and consequently should be avoided.

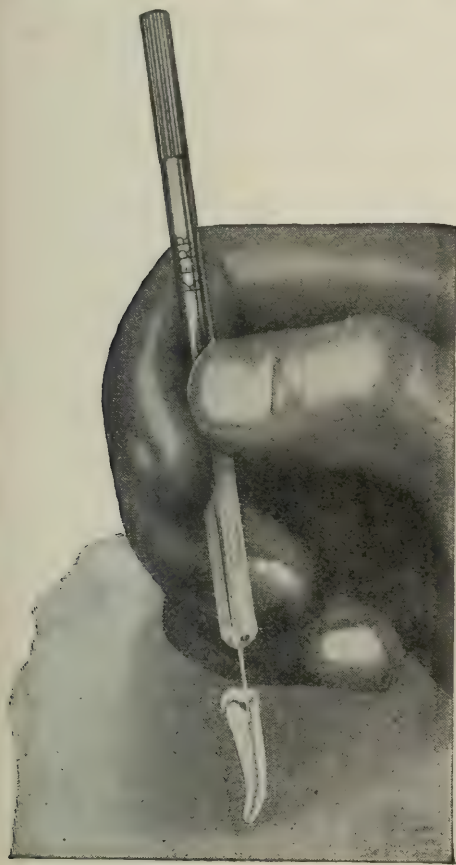


FIG. 274.—Reaming the canal with a Kerr twist broach.

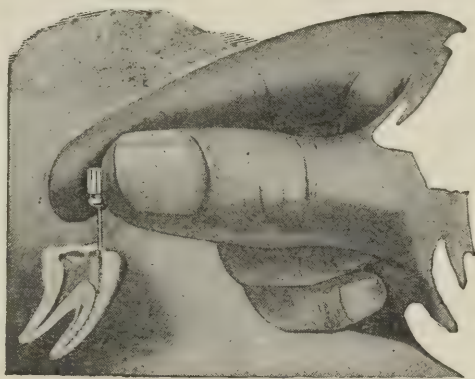


FIG. 275.—Enlarging the canals of a lower molar with a Nub broach.

(e) **Small Canals.**—In small canals, where entrance with a barbed canal cleanser is difficult, change to a spiral broach reamer, or a **twist broach**. Start with the smallest size, carefully boring in and withdrawing in a direction which will tend to straighten the canal, gradually changing to larger and larger sizes, until the canal is thoroughly opened (Figs. 274 and 275).

(f) **In difficult cases** a 50 per cent. solution of sulphuric acid, or better, phenol-sulphonic acid (which latter more readily clings to the broach), carried into the canal on the broach, will, by uniting chemically with the calcium salts of the dentin, soften the walls of the canals and render the work easier. Its action should be *neutralized* on completion of the operation with a saturated solution of sodium bicarbonate.

(g) Remove all débris.

(h) After the proper medicinal treatment has been given, depending on the conditions present, as already described, the canals are ready for drying and filling.

Wrapping Cotton on Smooth Broaches.—The method varies, depending on whether the cotton, containing some medicament, is to be temporarily left in the canal, or whether it is to be immediately withdrawn on the broach, as in swabbing or drying the canal.

1. **When the Cotton is to be left in the Canal.**—(a) Place a few wisps of cotton on the pulp of the forefinger of the left hand. (b) Lay a round or square smooth broach on the cotton, allowing the end of the cotton to extend slightly beyond the point of the broach. (c) Rotate the broach to *right* with the thumb and fingers of the right hand, at the same time rolling the cotton in the same direction with the thumb and forefinger of the left hand. Roll the cotton fairly tightly at the point of the broach and loosely the rest of the way. (d) Fold the slight excess of cotton left at the end of the broach over that already rolled and roll it in the same direction as before, so as to thoroughly cover the point of the broach. (e) Carry the broach containing the cotton as far as possible into the canal to be treated. (f) Rotate a turn to the *left*, at the same time withdrawing it a short distance, when the cotton will be disengaged. (g) Pack the cotton further into the canal by pushing the broach slightly forward,

and then, again rotating to the *left*, withdraw a short distance, continuing in this manner until the broach is entirely free of the canal and the cotton remains in position.

2. **When the Cotton is to be Withdrawn on the Broach.**—

(a) File off the sharp point of the broach or nick it off with a pair of scissors, leaving it slightly roughened, so that the cotton will be held more securely. (b) Wrap the broach with the cotton as already described, except that it should be wrapped *tightly* throughout the procedure. (c) Carry the broach into the canal and on withdrawal, rotate to the *right*, when the cotton will remain on the instrument. (d) To remove the cotton from the broach grasp it firmly between the thumb and forefinger of the left hand and twist the broach to the *left* with the right hand.

FILLING CANALS

It is necessary that the canals to be filled have been **thoroughly treated** under aseptic precautions, the saliva excluded throughout the course of treatments, all débris and remaining decomposable material removed, and **absolute dryness** accomplished.

Drying Canals.—Wrap a few shreds of cotton on a smooth broach and swab out the canal, absorbing all moisture possible by changing the cotton on the broach as often as necessary to accomplish the result. Instead of this procedure paper points provided for this purpose by the manufacturers may be utilized. Then force in a current of **hot air** from the heated bulb of the chip blower, or some of the various forms of root canal driers, until absolute dryness is accomplished, when the canals are ready to fill.

Requisites of a Good Canal-filling Material.—It should be

1. Non-irritant to the tissues of the apical space.

2. Indestructible in the fluids entering at the apex, or through the pulp chamber (in case of leaky fillings).
3. Easy of introduction.
4. Antiseptic in character.
5. Colorless.
6. Easy of removal (in case of trouble arising later).
7. Negative to the penetration of the Roentgen ray.

b

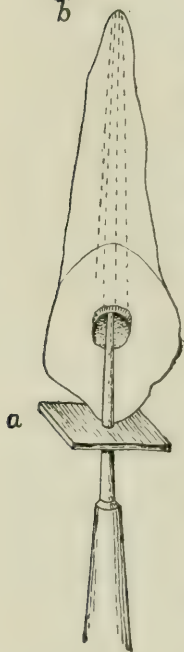


FIG. 276.—
Measuring the
length of the
canal.

Rule.—Endeavor *always* (a) to completely seal the apical foramen, (b) avoid forcing the material through, and (c) to so adapt the material to the walls of the canal that all air will be excluded and the canal for its entire length be hermetically sealed. The radiograph is valuable for “checking up” root-canal work at its termination.

Technic.

Several methods of filling canals will be described, one for large and the other for small canals.

1. FILLING LARGE CANALS.—Gutta-percha points. (Black’s method.)

(a) **Measure the diameter of the apical foramen.** Pass a small, smooth broach, or canal plugger, to the apex. If it passes through, change to a size larger, or two sizes larger, continuing until one is found which will pass just short of the apical foramen.

(b) **Measure the length of the canal.** Pass a small, smooth broach, or a hooked extractor, if the size of the canal will permit, to the apical foramen, catching the hook over the apex, if the latter instrument is used. A small piece of cardboard or rubber dam encircling the shaft of the broach is moved until it is in contact with the crown of the tooth,

when, the broach being withdrawn, a measurement of the length of the tooth is seen, and a guide as to the length of the canal is obtained (Fig. 276).

(c) **Select a tapering Gutta-percha cone** (Fig. 277), approximating the size of the canal, and cut off its end, until it is the size of the apex as previously determined.

(d) **Cut off a section** about 3 or 4 millimeters in length, which will be utilized for filling the apical portion. Also cut the rest of the cone into small sections for filling the balance of the canal.

(e) **Wrap a smooth broach** with a few shreds of cotton, dip it in eucalyptol and freely moisten the canal. Avoid too much cotton on account of the danger of forming a piston and forcing the solution through the apex. Remove all excess of eucalyptol with a broach wrapped with dry cotton, *leaving the wall slightly moistened with eucalyptol*.



FIG. 277.—Gutta-percha canal points.

(f) **Catch up the smallest section** of a Gutta percha cone on the end of a warmed root canal filler, dip it in eucalyptol, remove the excess, carefully carry it to place and tamp to position, withdrawing the plugger, when the apical portion is filled.

(g) **Continue the procedure** with the next largest pieces in order, carefully packing to position, and **warming** the largest pieces, until the canal is filled; then **seal** the pulpal opening with a warm plugger or burnisher.

(h) **Fill the pulp chamber** with Oxyphosphate of Zinc Cement.

2. FILLING SMALL CANALS.—(Gutta-percha and Eucapercha). Buckley's method.

(a) **Moisten the canal with eucalyptol** as before.

(b) **Dip a small, smooth broach**, on which are wound a few fibers of cotton, into softened euca-percha and pump the canal as full as possible, avoiding forcing the material through the apex.

(c) **Force in on a smooth broach**, squared on the end, a small section of a gutta percha cone, as large as the canal will accommodate, and *seal the entrance* to the canal with a warm canal plugger or burnisher.

(d) Fill the pulp-chamber with cement.

Callahan's Method.—After burning out the organic matter from the tubules and accessory canals with 40 per cent. sulphuric acid, followed by a saturated solution of sodium bicarbonate, and drying thoroughly, pump the canal full of chloroform and resin mixture (resin 12 grains, chloroform 3 drams). This mixture permeates and seals the orifices of the tubules and accessory canals. Then take a gutta-percha point of suitable size. Insert it into the canal while the resin is still liquid, and by a pumping motion frequently repeated (forty to sixty times), dissolve the point in the solution until the canal is thoroughly filled, thus further forcing the resin solution into the tubules and accessory canals at the apex, and filling the main portion of the canal with gutta-percha, which is slowly transformed into chloro-percha by gradually becoming dissolved in the solution. A recent modification of the Callahan method is to pump the canal full of chloro-percha after insertion of the chloroform and resin mixture, and then insert a suitable sized gutta-percha point. Also, if the apical foramen be large, it may first be filled by tamping in place a small section of gutta-percha point, to avoid forcing the resin and chloro-percha through the opening.

Other materials occasionally used for filling canals are:

Chloro-percha; oxychloride of zinc cement; paraffin, alone

or mixed with salol, aristol, or iodoform; salol; Prinz' root canal filling (composed principally of bismuth and paraffin). *Chloro-percha preparations, as well as the resin solution, for canal filling should have a small percentage of bismuth sub-nitrate added to them, else they do not show properly under the X-ray.*

Making Gutta-percha Points.—These may be obtained ready prepared. An excellent method of making them in the laboratory of various sizes and shapes is as follows: Warm a clean, smooth cement slab. Cut off a small section of **Gutta-percha base-plate**, and after heating it over the alcohol lamp, roll into a cone between the clean thumb and forefinger. Lay it on the warm slab, and with a warmed, broad, clean cement spatula, roll it out quickly into a long rope. As the rope gets longer and longer it will be convenient to hold one end by pressing it on the slab while using the spatula in the other hand, and working it with a back and forth movement. The roll, as it approaches the proper size, may be cut into sections, and then each section may be rolled separately into any size desired. These sections may then be cut into convenient lengths, with the hot spatula or a knife.

Technical Exercises

1. Open the pulp chambers and canals of the teeth prepared under Pulp Treatments, the presence of the wax covering the apices of the roots serving as a guide to prevent the passage of the canal instruments too far.

2. Seal in the pulp chamber and canals several cotton dressings containing anodyne, antiseptic and formo-cresol treatments.

3. Remove the dressings, dry and fill the canals after the methods described.

CHAPTER IX

INFECTIONS OF THE PERI-APICAL TISSUES

ACUTE ALVEOLAR ABSCESS—CHRONIC ALVEOLAR ABSCESS—ORAL FOCI OF INFECTION—CHRONIC ABSCESS WITHOUT SINUS—CHRONIC ABSCESS WITH SINUS

Acute Alveolo-Dental Abscess

The causes of this condition are the entrance of pus-forming germs and the escape of the gases and intermediate products from a putrescent pulp into the tissues of the apical space. Lack of aseptic precautions in treating canals, and imperfectly treated and filled canals are also frequent causative agents. An abscess on an adjoining tooth, or infection from a pyorrhea pocket may also extend by way of the circulation, or by continuity of tissue, and produce the condition.

As a result of infection, the periapical tissues become subject, first, to arterial hyperæmia, leading into venous hyperæmia and later inflammation of an acute type. Following the inflammatory stage, the tissues of the apical space are broken down and liquefied into pus, through the action of the suppurative and putrefactive germs present. This constitutes the *first or initial stage*. In the *second or perforative stage* the increasing pus formation takes the line of least resistance, and bores its way, in the majority of cases, through the alveolar plate of bone on the labial or buccal aspect of the affected root and into the overlying soft tissues. In the *third stage* the advancing pus perforates the soft tissues, making an opening about one-third of an inch below and slightly to the

distal side of the apex of the affected root. In this stage swelling of the soft tissues is usually marked.

In other cases, however, the pus, taking easier avenues of escape, will open to the lingual side, in the roof of the mouth, into the nasal cavity, the antrum, the inferior dental canal, the fauces, on the cheek, below the chin, beneath the angle of the jaw, or at far-distant points. In cases of open cavities, the pus may find exit by way of the canals, constituting the condition, sometimes erroneously designated as *blind abscess*.

During the progress of the condition, the bone and overlying structures are constantly being broken down, liquefied and transformed into pus. After perforation has occurred, the condition remains, if untreated, as a chronic abscess cavity at the root end, with a sinus leading from it to a fistulous opening at the point of exit. If perforation does not occur, as occasionally happens, and the case does not receive treatment, a chronic abscess without fistula is established, the pus draining through the canals or being absorbed into the vascular and lymphatic streams, the latter condition being true blind abscess.

Treatment

The treatment in the main is *abortive* in character, to prevent the spread of the infection and the continued formation of pus. It is divided into (a) local and (b) general or systemic treatment.

The **local treatment** may be described as follows:

Under aseptic precautions, open into the pulp chamber, either through a cavity, old filling, or the lingual, or occlusal surface of undecayed teeth. As soreness is usually present, pressure may be somewhat relieved during the necessary drilling, by traction on a ligature tied around the affected tooth, or the use of a modeling compound splint held in position over

several adjoining teeth during the necessary drilling. The rubber dam should, as a rule, not be applied at the first sitting, owing to the excessive soreness of the tooth. Broach out the canals as well as conditions will admit, to relieve the pressure of the confined gases and allow drainage for pus formation. Flush out with an antiseptic solution, absorb pus from the canals on cotton or paper points, and either (1) pump in an anodyne antiseptic, such as camphophenique, Black's 1-2-3, or phenol compound, leaving the tooth open to allow for drainage, repeating the treatment at intervals of a few hours until relief is secured; or (2) according to Buckley, seal in for a few hours, to be repeated at increasingly longer intervals, formocresol, as in an ordinary treatment for putrescent pulp. In either case, counter-irritation to the gum or scarification in the early stages, or, in the later stages free lancing of the gum, drilling through the bone to the apex of the affected tooth with a spear point drill or trephine, and the use of a tent for drainage is frequently indicated.

As counter irritants one of the following remedies may be applied, viz.: Tincture of iodin and aconite, equal parts, capsicum plasters, black mustard papers cut to proper size, cantharidal collodion, or one of the following prescriptions:

R _x . Mentholis.....	gr. xx
Chloroformi.....	℥i
Tincturæ Aconiti, q. s.....	ad ℥i(Buckley.)
R _x . Tincturæ Aconiti.....	℥ii
Tincturæ Iodi.....	
Chloroformi.....	aa ℥i(Buckley.)

In some cases, in the later stages, where other methods fail, heat may be applied to the gum in the form of hot water, a split raisin sprinkled with capsicum, or a capsicum plaster, to hasten suppuration and pointing. Antiseptic mouth washes should be freely used.

Systemic Treatment.—1. *Administer Alteratives* to aid nature in readjusting the parts to a normal condition.

Rx. Potassii iodidi, ... ℥ss
 Syrupi sarsaparillæ compositi, ... ℥iii
 Sig. Teaspoonful every 2 hr. until three or four doses,
 then three times a day.

2. *Saline cathartics*, such as Epsom salts, Seidlitz powders, or Citrate of Magnesia are useful to lower the force of the circulation, withdraw blood from the affected area, and enable the system to throw off the toxins that are being absorbed into the circulation.

3. *Relieve pain and reduce fever* by the use of trigemin, acentanilid, phenacentin or, as a last resort, opium or its derivatives.

Rx. Pulveris Acetanilidi compositi, ... gr. xxv
 Ft. Capsulæ No. 5,
 Sig. Take one every 2 hr.

4. *A hot mustard foot bath* to draw the blood away from the affected area to the lower extremities is of value.

The prognosis of acute alveolar abscess is usually good, as far as preservation of the tooth is concerned, especially if treatment be applied early. In cases of extreme boggy swelling, great involvement of the tissues of the face, and evidences of extreme septicemic infection, extraction is sometimes the only alternative. In these cases it is frequently a matter of nice judgment to determine whether to extract at once or to use measures to hasten suppuration and pointing, deferring the operation until subsidence of the acute symptoms. Occasionally it will be wise to defer the operation, rather than run the risk of stimulating an increase of the constitutional manifestations and systemic infection, as a result of the operation. In many instances, however, where the indications point to a very grave termination, due to marked

septicemia, it will be the part of wisdom to extract immediately under aseptic precautions, curetting and giving the tissues subsequent antiseptic and stimulative treatment.

Focal Infections of Dental Origin

Special attention has been previously called in this work to the close anatomic, physiologic and pathologic relationships existing between the teeth and supporting structures and all other parts of the body. Infection surrounding the roots of the teeth may, and frequently does, extend by way of the vascular and lymphatic systems, as well as by continuity of tissue, to closely associated or far distant parts. As a result, many very grave systemic disorders, either of a vague or definitely manifested nature are produced.

Certain micro-organisms, located in a root canal or in the periapical tissues may be of a harmless nature under the conditions in which they are placed. However, according to Hartzell and Rosenau, if they succeed in entering the blood and lymph streams and are transmitted to other tissues, they may, in their new environment, change their form and characteristics (transmutation) and be productive of great harm. A streptococcus from the tonsil or an alveolar abscess, may, under suitable cultural conditions, change to a pneumococcus, and, if it reach the lung, be productive of pneumonia; or if it reach some joint of the body, may cause arthritis deformans (rheumatism); or in other cases, the same micro-organism may locate in the valves of the heart, be transformed under its new environment into the streptococcus viridans and result in a heart lesion; under other conditions it may travel to the inner coat of the stomach and produce an ulcer of that organ. Under similar conditions, bacilli may be changed to spirilli, and other forms of germs may take

unto themselves entirely different forms and activities. Harmless bacteria are thus seen to be frequently capable of producing great harm under changed environment, and the opposite result may also occur, viz.: harmful species may lose their virulence under different cultural conditions. In septic diseases occurring in the apical space, pus-forming micro-organisms are usually present, which, traveling to distant parts, may, under the changed conditions in which they are placed either lose their virulence or be stimulated to increased activities. The normal resistive power of the tissues involved, in addition to other factors concerned, will undoubtedly have a definite influence on the result produced.

According to Clarence J. Grieves, the following disturbances may result from focal infections located in or about the teeth.

1. Affections of the muscles (myositis),
2. Affections of the joints (arthritis and synovitis),
3. Affections of the blood (septic anæmia, endocarditis, and pleurisy),
4. Affections of the glands (lymphadenitis),
5. Affections of the nerves (toxic neuritis and degenerations),
6. Affections of the excretory organs (skin rashes and nephritis),
7. Affections of the intestinal tract (septic gastritis, enteritis, cholitis, cholecystitis and appendicitis).

In many instances systemic infections of this nature are easily recognized, diagnosed by the physician and traced to infections about the teeth as causative agents, but perhaps just as frequently the constitutional disturbance is of a very vague nature without markedly definite manifestations. Some of the vague symptoms observable in these cases are anæmia, pallid or pasty complexion, general malaise, loss of

appetite, debility, night sweats, loss of weight, low fever (100°F.), or sub-normal temperature. Many cases of this kind have been cured by the removal of infections in the mouth, either through thorough sterilization and filling of root canals, treatment of chronic alveolar abscesses, extraction of the affected teeth, removal of the tonsils, eradication of pyrohea pockets, treatment of antral disease, abandonment of faultily constructed crowns and bridges and other sources of infection.

It is then highly important for the dentist to fully realize the great significance of the bearing which his root canal operations may have on the health and even life of his patient. It is, however, equally important for him to recognize the fact that the above mentioned disturbances may, in many instances, have no connection whatever with oral conditions, but may be due to entirely different causes, viz., the focus of infection producing the disturbance may be situated in an entirely different part of the body. The significance of conditions of this nature was not fully appreciated by either the medical or the dental profession until recently. A full realization of their import has often resulted in the adoption of extremely radical measures for their relief by many men in both professions, with the result that thousands of teeth have been needlessly and ruthlessly sacrificed during the past few years through the extraction operation. The radical element in the medical profession has been especially guilty in this regard, referring patients to the exodontist whenever they were unable to discover other causes for systemic disturbances, and not realizing or recognizing the full importance of the necessity for the retention of the teeth for preservation of the continuity of the arch. A similar class of dental practitioners, prone to enthusiastically subscribe to new fads, has been equally guilty, with the result

that great harm has been done. However, it would seem that a normal, sane attitude is about to be reached by both professions in regard to questions of this nature.

The solution of the problem lies in the establishment of closer affiliations between the two professions, and a closer study, on the part of both, of the diagnostic, pathologic and clinical relationships of these disturbances. An imperfectly filled pulpless tooth or a partially healed infection at the apex of the tooth is always likely to be suddenly transformed into an active source of systemic infection, if the resistive powers of the body be low, from any cause, and especially so if the normal resistance be temporarily or permanently lowered from some systemic disturbance arising after the dental operation has been performed. Operations of this nature, even if they are believed to be well-nigh perfect, as revealed by the X-ray, may suddenly give trouble and become active sources of infection in constitutional disturbances, lowering the resistance of the tissue cells of the patient, since, as is well known, a single micro-organism left in position and suddenly springing into activity may multiply at a rapid rate and transform the apparently successful operation into a local focus of infection which may become a menace. Great caution should be exercised in determining whether teeth from which pulps are to be or have been removed, or which are affected with disturbances of the periapical tissues, should be retained in the arch or extracted. The promiscuous extraction of teeth of this type is unscientific and should be discontinued. The decision as to whether a tooth should be retained or extracted should be determined by the skill and ability of the operator to cope with the technical difficulties involved, the importance of the tooth as a part of the masticating machine, as a means of retention for artificial substitutes, the probabilities of a successful outcome as far as thorough sterilization and filling

of the canals and treatment of the apical complications is concerned, and also on the systemic condition of the patient.

DIAGNOSIS AND PROGNOSIS

The use of the X-ray is the most valuable diagnostic measure in these cases, and it should be resorted to for this purpose at the beginning of all cases where root canal work is to be attempted. Anterior teeth with straight, well developed roots, offer the best prognosis, the bicuspid next, while molars, owing to the technical difficulties involved, afford the poorest chances of a successful outcome. Pyorrhetic teeth, affected with apical complications, are usually poor risks, and in many instances had better be extracted at once. Types of cases usually unfavorable for treatment are those in which there is too much dead apical cementum, resulting from extensive chronic alveolar abscess, those on which there is a large amount of dead alveolar cementum as exhibited in pyorrhea cases, and teeth with abscesses opening into the antrum. In cases of this nature, the pericementum is often extensively destroyed, the cementum encrusted with calculus, necrotic, and pus-soaked, and in a condition which it is impossible to restore to the normal state. In the latter types, extraction is usually advisable. In the milder forms of chronic apical infection, and even in some of the cases of more extensive granuloma, the operation of excision of the root end, to be described later, may be performed and the tooth restored to prolonged periods of usefulness.

In reading the radiograph, which should be made in every instance, teeth known to be normal should be studied first, with the assistance of a reading glass or denticope. On a normal tooth, the periodontal membrane may be seen as a continuous radiolucent line encircling the root. Surrounding

this will be noted the lamina dura, exhibited in the form of a radiopaque line. The trabecula of bone at the apex and outside of this line should appear homogeneous with the surrounding bone.

In some instances the apical space surrounding teeth recently infected or infected with micro-organisms of low virulence may appear perfectly healthy in the X-ray film, while teeth suffering from the effects of traumatic occlusion, or chronic inflammatory disturbances of the apical tissues may exhibit an apparent rarifying process in the surrounding bone, simulating infection. Consequently, it should be

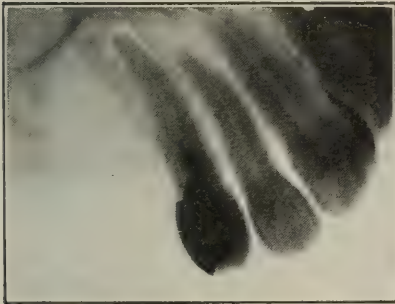


FIG. 278.—Small granuloma on the cuspid. Canal unfilled.



FIG. 279.—Granuloma on lower anterior teeth. Teeth badly affected with pyorrhea.

remembered that the appearance of a radiolucent area at the apex does not always signify the presence of infection. Many errors in diagnosis are thus made from an imperfect understanding of this fact. The radiograph, is then, not an infallible guide in the diagnosis of infective conditions of the periapical tissues.

When it is decided to attempt the preservation of teeth affected with septic conditions at the root end, the responsibility should be assumed alike by patient and operator,

and the possibilities of future complications fully explained. The case should be X-rayed at the termination of the operation, again at intervals of 1, 3, 6, and 12 months, and again at occasional periods. A successful termination will be indicated



FIG. 280.—Badly infected roots.

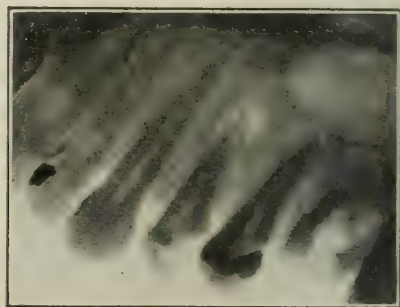


FIG. 281.—Granuloma on the first bicuspid.

by progressive filling in of the affected area with new bone formations, which should be complete and homogeneous after periods ranging from 1 to 2 years. In case these procedures cannot be followed, it may be deemed the part of

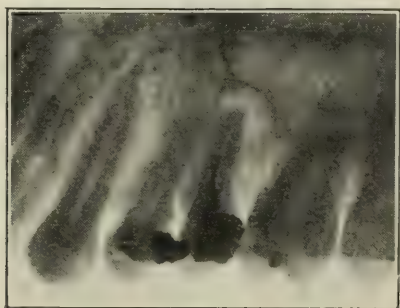


FIG. 282.—Large granuloma on the second bicuspid.

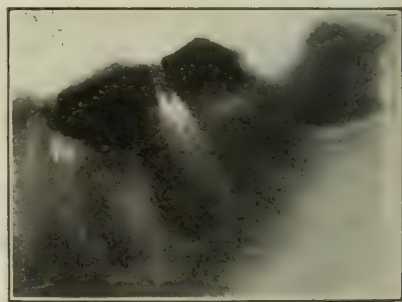


FIG. 283.—Large granuloma on the lower first molar. The third molar is impacted.

wisdom to extract, rather than assume the risk of subsequent complications.

As a rule, teeth affected with granuloma had better be

extracted, if present in the mouths of patients suffering from arthritis, heart, kidney, or splenic affections, or some other form of grave disturbance for which definite causes cannot be found. Patients of the above type are peculiarly susceptible to infections, and the dentist is not justified in subjecting

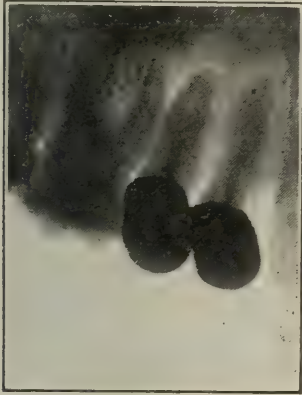


FIG. 284.—Granuloma affecting bicuspid and root of first molar.



FIG. 285.—Badly infected central and lateral roots.

them to additional possible sources of infection. The cooperation of the physician and laboratory technician should be secured in making a decision in cases of this nature. Great



FIG. 286.—Extensive granuloma.



FIG. 287.—Extensive granuloma on lower third molar.

significance should be attached to the urinary analysis, the blood picture and blood pressure indications. The majority of patients suffering from streptococcal infections exhibit low

blood pressure, low hemoglobin index and deficiency of red and white blood cells with a lymphocytosis. The minority vary from normal to very high blood pressure with an exhibi-



FIG. 288.—Large granuloma.
Protruding canal filling.

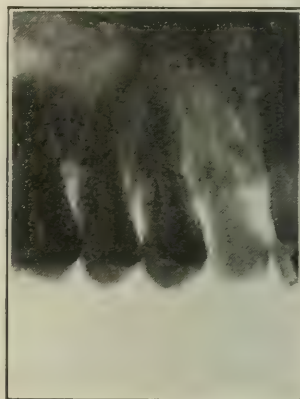


FIG. 289.—Marked case of
absorption surrounding the
root of an upper cuspid.

tion of leucocytosis. With a little training, the dentist should be able to estimate, approximately at least, the state of arterial tension of the patient and be guided accordingly. (See Figs. 278 to 290.)

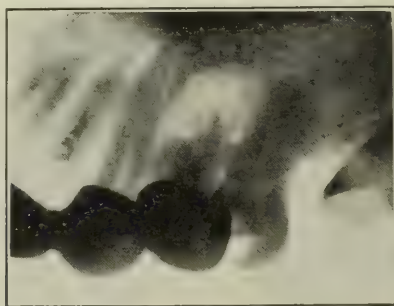


FIG. 290.—Pronounced case of pus formation affecting many teeth. One tooth presents badly absorbed roots.

CHRONIC ALVEOLAR ABSCESS

Causes.—The causes of this condition are the same as those producing the acute variety. The condition is one in

which pus formation is fully established, the tissues of the pulp are largely broken up, and the apical tissue has been destroyed to a point where an abscess cavity is present in that locality, while the acute symptoms of pain, tenderness and swelling have largely subsided. (See Figs. 264 to 290 inclusive.)

There are two varieties of Chronic Alveolar Abscess, viz:

1. *Abscess without sinus*; the pus discharging via the root canal (false blind abscess), or being absorbed via the lymphatics and the blood streams (true blind abscess).
2. *Abscess with sinus*; the pus having bored its way through the overlying bone and opening externally.

Dangerous conditions are liable to arise from masked cases of chronic abscess without sinus. Local foci of infection may be established, in which the pus and toxic products are slowly absorbed via the lymphatics and blood streams, producing general depression of the metabolic functions of the system, and resulting in lowered vitality, infections in other parts, loss of vigor, sleeplessness, anorexia, anæmia, leukaemia, intestinal disturbances, rheumatism, arthritis and vague disturbances of internal organs.

Treatment.—Open the chamber and canals under aseptic precautions, remove the contents, evacuate the pus by pressure over the apex of the tooth and swabbing of the canals. Dry the chamber and canals and seal in formo-cresol, modified formo-cresol or other antiseptics. Repeat the treatment frequently, sometimes daily, until the pus flow stops; then seal in a mild, antiseptic, anodyne treatment for a week or ten days; then, if the case is healed, as evidenced by stoppage of discharge, disappearance of all odor, tenderness and other symptoms, the canals may be filled. *Over-treatment*, or too frequent treatment will sometimes result in the prolonged continuance of a serumal discharge, which is not pus. In

these cases, dilute the formo-cresol remedy, or use campho-phenique, phenol compound, Black's 1-2-3, or Eucalyptol compound. If, after using one or the other of these remedies, and serum continues to exude, dry and fill the canals, and give the case physiological rest for a week or two, before placing the permanent filling in the crown of the tooth.

In case the *Routine treatment*, as described, fails, in very mild and simple cases the *Acid Treatment* may be tried. There are probably complications present, which require additional remedies to stimulate granulation and healing. In these cases, force through the apical foramen, after the method of pressure anesthesia, phenol-sulphonic acid, 50 per cent. sulphuric, or aromatic sulphuric acid, or 15 per cent. trichloroacetic acid, to stimulate granulation. Before doing this, evacuate the pus and then after the acid injection, seal in modified formo-cresol or the other agents previously mentioned. This acid treatment may be repeated at a subsequent visit, if necessary, and will frequently check the condition. If another tooth is involved, that should also be opened and treated. The acid treatment should not be attempted in cases of granuloma with extensive involvement of the root end and apical tissues.

If the *Acid Treatment* fails, or is not adopted, then establish an artificial sinus and treat as described under "Abscess with Sinus," or perform the operation of apexotomy.

Two methods may be described for establishing an artificial sinus.

1. *Black's Method*.—Immerse the face of a foot-shaped plugger in phenol, and touch to the gum over the apex of the affected tooth. Repeat the procedure and continue in this manner, applying slight pressure until the bone is reached, when a spear drill, dipped in phenol, is quickly run through the alveolar plate to the root apex. Excess of phenol should

be avoided or neutralized with alcohol, to prevent spreading to adjacent tissues.

2. *The Routine Method*, which is the one largely used at present, consists in the use of a local anesthetic, such as Ethyl chlorid or conductive anesthesia, after which, under aseptic precautions, the gum is lanced to the bone and the periosteum turned up with an excavator, small scaler, chisel or periosteotome. The bone is then drilled through to the apex of the root, following which, after clearing the canals, normal saline solution, peppermint water, or cinnamon water is injected from the root canal with a hypodermic syringe (around the needle of which is packed unvulcanized rubber) through the fistulous opening. This forcible injection still further establishes the fistula, and forces out the contents of the abscess tract, completing free drainage. After free drainage is established, force through from the root canal, by means of unvulcanized rubber, after the method of pressure anesthesia, phenol, phenol compound, phenol-sulphonic acid, sulphuric or aromatic sulphuric acids, to cauterize the tract.

In addition to establishing the sinus, the sealing into the canals of the same medicaments used for abscess without sinus, the flushing of the sinus through and through, with the bland solutions previously mentioned, and the cauterizing of the tract are indicated. These procedures are repeated until healing occurs. In the majority of cases it will be deemed advisable to extract the affected tooth rather than to attempt procedures of this nature. In case all the previously mentioned methods of treatment fail, and extraction is not indicated, the operation of apicoectomy may be attempted.

Apicoectomy

First fill the root canal, after having obtained a radiograph. Then inject a local anesthetic, and, under aseptic precautions,

make a linear, or preferably a semicircular incision of the gum over the apex, cutting to the bone. Hold the tissues back with a gum retractor, and deflect the periosteum with a periosteotome. Now remove the overlying bone with chisels, or the bone may be drilled through with a surgical bur or drill. After exposing the root end excise it, or cut it off with a fissure bur, remove the excised portion with an elevator or excavator, and smooth up the end with a round bur. Some operators prefer to excise the root with chisel and mallet, although there is danger of splitting the root. Next curette the area, removing any necrosed bone present, flush out with an antiseptic solution, and in extensive cases, pack with sterile gauze. The packing should be changed every other day until granulation fills in the opening. In the majority of instances it is better practice to close the gum flap and stitch together with silk. In either case, the patient should keep the mouth clean with an antiseptic wash and the healing process should be observed by occasional subjection to the X-ray.

SOME RECENT METHODS OF TREATING SEPTIC CONDITIONS IN THE ROOT CANALS AND PERIAPICAL TISSUES

Silver Nitrate and Formalin. (Percy R. Howe).

Recently a combination of the double salt of ammonium silver and formalin has been advocated by Howe for the treatment of putrescent pulps and chronic alveolar abscesses. The author does not believe that this method should be used as a routine measure in the treatment of cases of this nature, owing to the marked tendency of the silver salt to produce discoloration of tooth structure. If forced through the apical foramen in uncomplicated cases of putrescent pulp, it is also strongly irritating.

The method of application, as advocated by Howe is as follows:

Under aseptic precautions, remove the contents of the pulp chamber and apply the silver nitrate solution (bottle number one), saturating the remaining pulp tissue in the canals. Then, after waiting about three minutes, apply the formalin (solution number two) and allow the mixture to remain in position three minutes, when the canals may be opened and their contents removed. Now apply on a smooth broach, or absorbent point, a drop of solution number one, manipulating the solution carefully with a smooth broach, avoiding forcing through the foramen. Then carry in, after an interval of three minutes, a drop of solution number two, and thoroughly broach out the canals. After an interval of another three minutes, dry the canals thoroughly and apply another drop of the silver ammonium solution (number one), to which is then added a drop of eugenol, and the broaching process continued. After three minutes, dry the canals and fill.

In cases of chronic alveolo-dental abscess, the same method of treatment is applied to the canals and the routine treatment for apical abscess is then instituted. During the abscess treatments, Howe recommends the sealing into the canals of Dakin's solution, during the intervals between the visits of the patient. After healing of the abscess, again make three or four applications of the silver ammonium formalin preparation in the canal, and then fill. If response to the treatment is not effective, the Howe preparation may be forced directly through the root end into the apical tissues. This latter procedure is cautioned against in uncomplicated cases, on account of the irritating effect produced on vital tissues.

Solution of Dichloramin-T:

This preparation is being advocated for the sterilization

of root canals and infected apical tissues, although it is still in a state of experimentation. Its principal disadvantages seem to be its marked tendency to produce irritation and an excessive flow of lymph. Until additional work is done with it, and its place is more definitely fixed, in the treatment of these conditions, the author cannot recommend its use. However, a brief description of the technic of its manipulation is herewith given.

A 5 per cent solution of the salt in chlorosane (chlorinated paraffin) is recommended by Herman Prinz. Dichloramin-T solutions deteriorate very rapidly, consequently, only fresh solutions should be used and these should be kept in glass-stoppered, amber-colored bottles, which protect them from the light. The solutions should be kept away from heat, light and contaminating substances of all kinds. To prepare an ounce of the preparation, 25 gr. of dichloramin-T are added to 1 oz. of chlorosane, the mixture thoroughly shaken, and the bottle placed in a pan of very hot water, when, at the end of 15 minutes, complete solution usually results. A few drops of the preparation should be removed from the container with a glass rod and placed on a glass tray ready for use.

Now, after opening the pulp chamber and canals, and thorough drying under aseptic precautions, carry the solution into the canals on an absorbent point. Do not use broaches for this purpose, as metals produce contamination of the liquid. With a pumping motion, thoroughly moisten the canals, and, in case of periapical complications, force the solution through the apical foramen into the infected area. The use of the warm air blast from a chip blower or hot air syringe helps to further diffuse the oily liquid into the finer ramifications of the canal or through the apical foramen. A fresh point carrying the dichloramin-T solution is now

sealed in the canal for 24 hours, at the end of which time the treatment is repeated and the solution sealed into position for another 24 hours. A third application is made in the same manner on the return of the patient, and left in position for 48 hours, at the end of which time the case is ready for filling, if all evidences of putrefaction have disappeared. Dichloramin-T, owing to the fact that it is an active lymphagogue, usually produces a marked serous discharge, which, it is claimed by the advocates of the method, is an advantage, especially in cases of septic conditions at the root end, on account of the increased tendency to produce efficient drainage.

IONIC MEDICATION: (Ionization).

During the past few years ionic medication of septic root canals and of infections of the periapical tissues has come into some prominence. This method of treating conditions of this nature has been recently advocated by M. L. Rhein, Weston A. Price, George T. Fette, and Sturridge, of England. At the present time, it may be said that the results obtained are not satisfactory and, unless improvements are made in the technic of application, the method is likely to be entirely abandoned.

The process consists in dissociating the ions of certain salts in solution, by means of a mild electric current, and thus driving them into the tooth structure and apical space. Two prominent forms of appliance for this purpose are the Ritter and the McIntosh ionization equipment. These appliances consist of current regulators and indicators for controlling, regulating and indicating the strength of the current, a cheek electrode, to be placed on the cheek of the patient, a tooth electrode carrying a metallic point, to be inserted into the canal to be treated, current and motor

generators and transformers, to be used in connection with direct or alternating street currents, and other accessories.

The chemical agents recommended for ionic medication by the previously mentioned authorities are zinc chlorid or sulphid, 3 per cent solution; copper sulphate, 2 per cent solution; silver nitrate, 3 per cent solution; and tincture of iodine and water, equal parts. The canal to be treated is saturated with one or the other of these solutions, the small tooth electrode needle is placed as deeply as possible in the canal, the face electrode is applied to the cheek of the patient, and the current is turned on and slowly increased in amount, thus dissociating the ions of the solution and driving them into the tissues to be sterilized. The strength of the current is increased to about three milliamperes for anterior teeth, and about five milliamperes for molars. The treatment is applied from one-half minute to 3 or 4 minutes duration, depending on the conditions present and the size of the teeth treated. Treatments are made every other day until pus flow ceases, and then at intervals of 3 or 4 days for several additional visits of the patient, at the end of which time, if all evidences of septic infection have disappeared, and healing has occurred, the canals are ready for filling.

CHAPTER X

TECHNIC COURSE FOR STUDENTS

The following table is an outline of the technical exercises described in the previous chapters. It offers to the teacher a wide scope in the matter of selection. The exercises marked with an asterisk are the ones which the author recommends.

DENTAL ANATOMY

A. Drawings.

*1. Outline drawing, three diameters, of the labial surface of the crown and root of the right upper central incisor.

*2. Outline drawing, three diameters, mesial or distal surface of the crown and root of the upper central incisor.

*3. Shaded drawing, three diameters, labial surface of the upper central incisor.

*4. Outline drawing, three diameters, labial surface of the crown and root of the right upper cuspid.

*5. Shaded drawing, three diameters, of the labial surface of the same tooth.

*6. Outline drawing, three diameters, of the buccal surface of the crown and root of the right upper first bicuspid.

*7. Outline drawing, three diameters, of the mesial or distal surface, crown and roots of the same tooth.

*8. Shaded drawing, three diameters, buccal surface of the crown and root of the upper second bicuspid.

*9. Outline drawing, three diameters, of the mesial or distal surface of the lower first bicuspid.

*₁₀. Shaded drawing, three diameters, of the occlusal surface of the upper first bicuspid.

*₁₁. Outline drawing, not to measurement, of the buccal surfaces, of the upper and lower bicuspids, showing the most frequent location of the points of the cusps.

*₁₂. Outline drawing, three diameters, of the buccal aspect of the crown and roots of the right upper first molar.

*₁₃. Shaded drawings, three diameters, of the occlusal surfaces of the right upper first, second and third molars.

*₁₄. Outline drawing, not to scale, showing the molar triangles.

*₁₅. Outline drawings, not to scale, of three cubical figures, indicating the location of the surfaces, margins and angles of the lower molars.

*₁₆. Shaded drawings, three diameters, of the buccal surfaces of the crown and roots of the left lower first and second molars.

*₁₇. Shaded drawing, three diameters, of the mesial surface of the crown and roots of the lower first molar.

*₁₈. Shaded drawing, three diameters, of the occlusal surface of the left lower first molar.

*₁₉. Shaded drawing, three diameters, of the occlusal surface of the right lower second molar.

*₂₀. Outline drawing, not to scale, showing the teeth in occlusion.

*₂₁. Outline drawing, not to scale, showing the labio-lingual inclination of the upper and lower central incisors.

*₂₂. Outline drawing, showing the mesial inclination of the same teeth.

*₂₃. Outline drawing, showing the bucco-lingual inclination, of the upper and lower molars.

*₂₄. Shaded drawing, showing the enamel, dentin, cementum and pulp of the upper central incisor.

B. Carvings.

1. **Carving Teeth in Plaster.**—Carve to Black's measurements, five diameters, the upper central and lateral incisors, the upper cuspid, upper first bicuspid and upper first molar. Preliminary cavity preparation work is done on these later.

2. **Carving Teeth in Soap.**—Carve all the teeth, upper and lower of one side, to exact measurement.

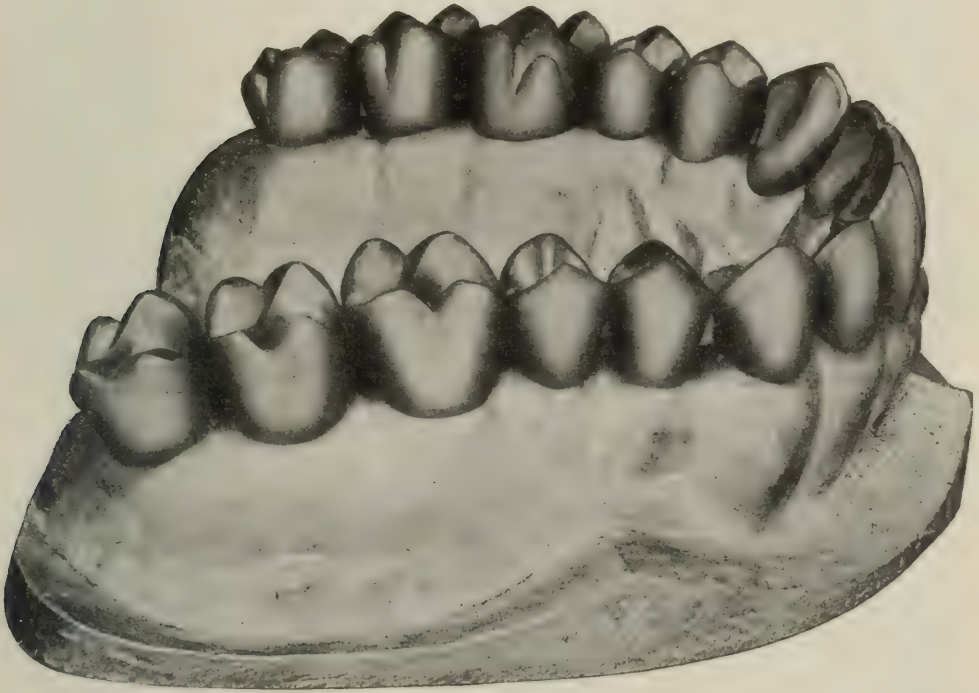


FIG. 291.—Enlarged aluminum model used by the author for teaching dental anatomy.

3. **Carving Teeth in French Chalk.**—Carve to scale the upper and lower central and lateral incisors, the upper and lower cuspids, the upper first and lower first and second bicuspid, the upper first and lower first and second molars.

*4. **Carving Teeth in Ivory.**—Carve to exact measurement the upper central and lower lateral incisors, upper and lower cuspids, upper first bicuspid, lower first and second bicuspid, upper and lower first molar, of one side.



FIG. 292.—Same model as shown in Fig. 291 carrying teeth with typical cavity preparations.



FIG. 293.—Dr. H. Gale Atwater's model and instruments. Both are made to Black's measurements, 25 diameters. A model of the lower teeth, not shown, is also used. In the illustration, ideal cavity forms have been completed. Enlarged matrices may be seen to the right of the picture.

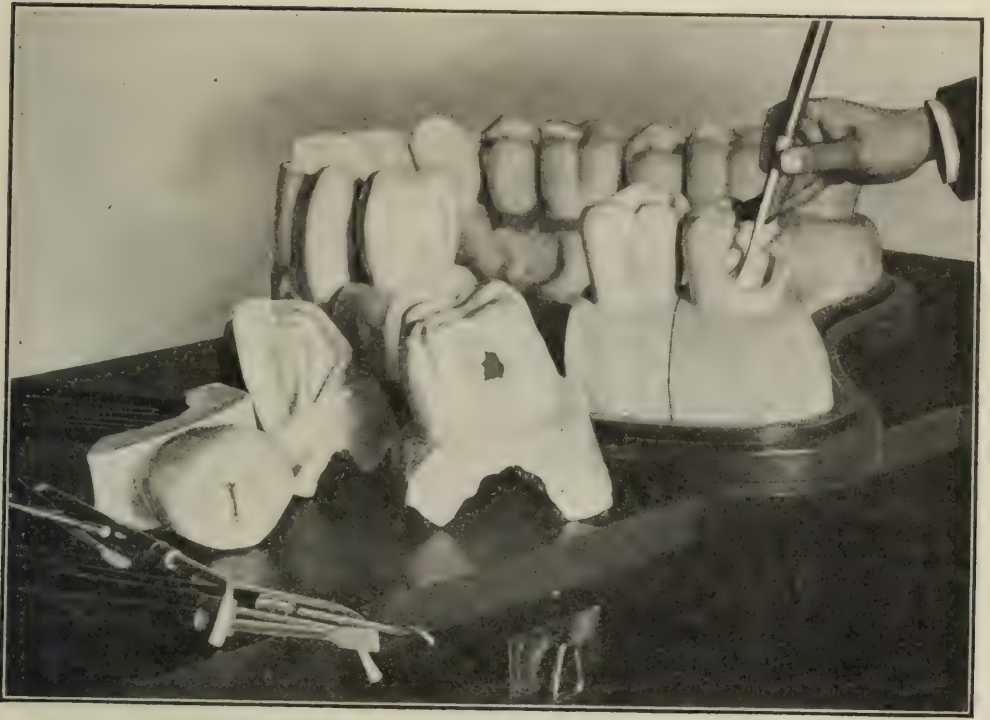


FIG. 294.—Another view of Dr. Atwater's model and instruments. Typical cavities of decay are seen, while the instrumentation incident to the preparation of a cavity on a molar will be noticed. The various pathological conditions incident to the formation of a cavity through the process of caries (such as partially affected dentin, the bacterial zone, leathery decay, brown caries, ptomaines and food debris) are imitated on these models.

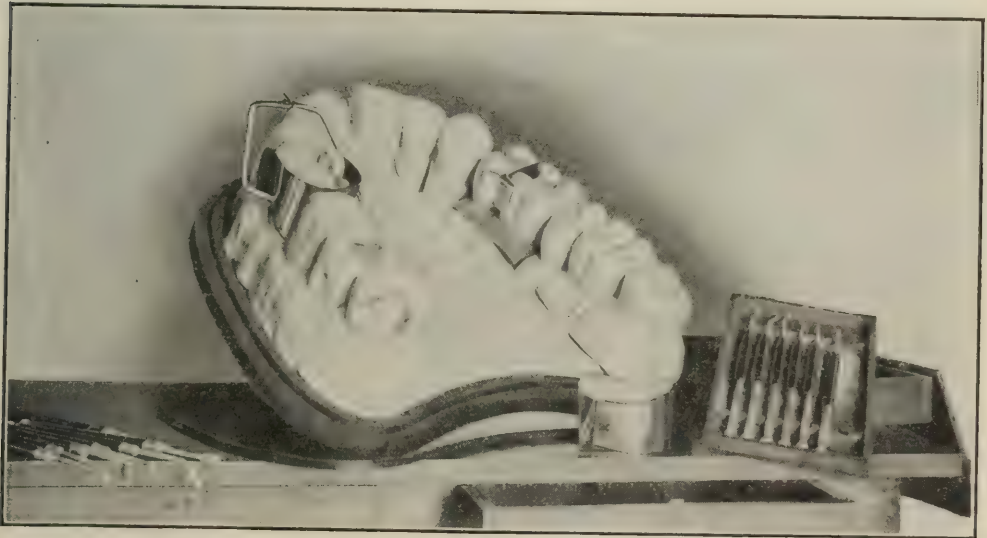


FIG. 295.—Another view of the model used in the University of Southern California, Dental Department.

***C. Sawing and Filing Sections.**—Make one longitudinal and three transverse sections of the upper and lower teeth, right or left side.



FIG. 296.—The typodont. No. 1.

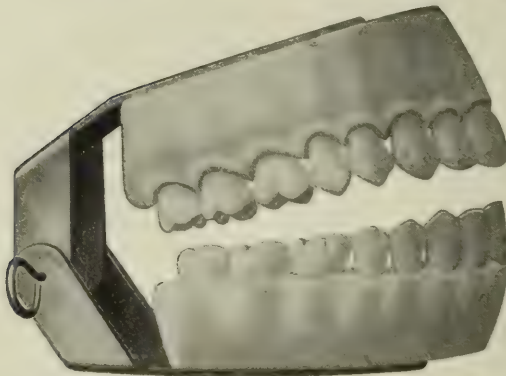


FIG. 297.—The typodont. No. 2.

D. Making Prints.—Make prints in ink of the sections cut

OPERATIVE TECHNICS

A. Instrument Making.

- *1. Make from piano wire six smooth broaches.
- *2. Make from the same material six hooked extractors.

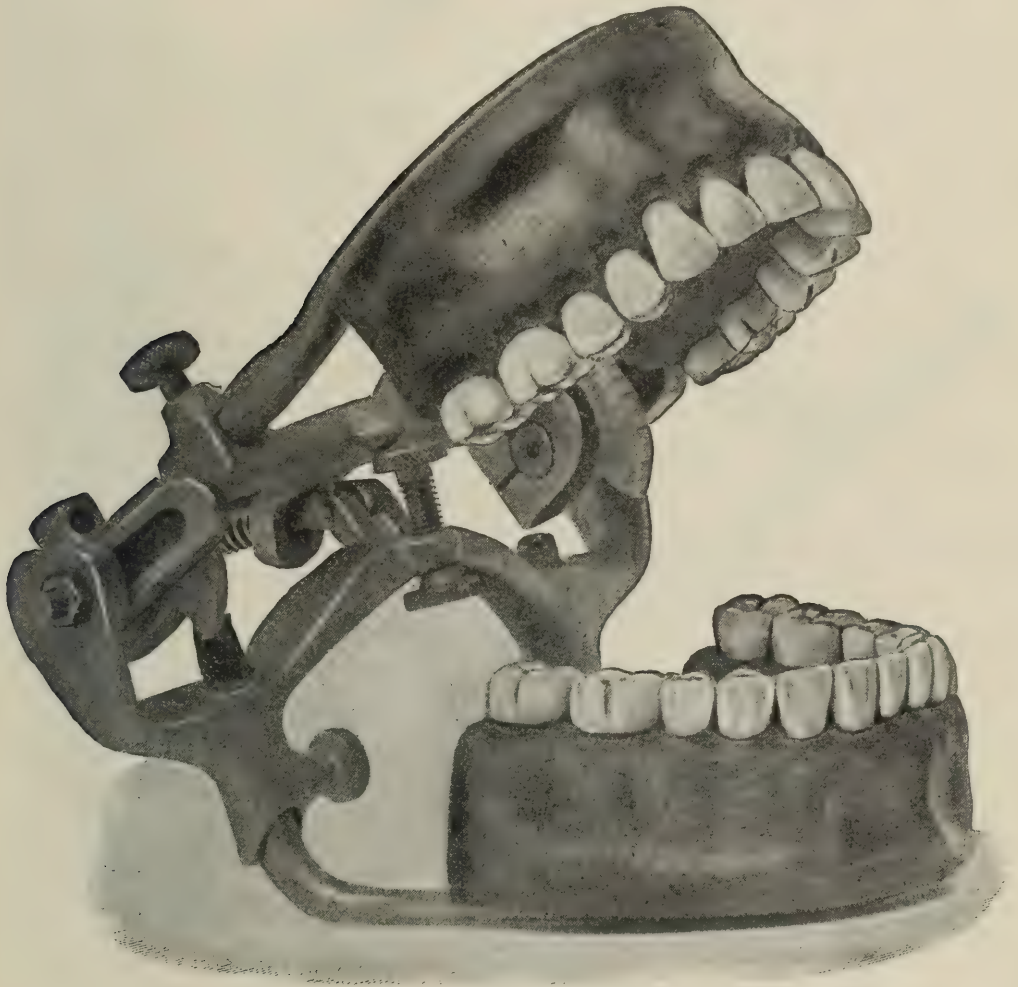


FIG. 298.—The odontotype. Nos. 1 and 2.

- *3. Perform the exercises on pages 43, 44 and 45 illustrating Annealing, Hardening and Tempering.
- *4. Make from steel blanks six excavators or chisels.
- 5. Make from annealed brass wire, 13-gauge, the blade and shank of all the excavators and chisels in the college list.

B. Use of the Separator, Absorbents, Rubber Dam and Matrix.

*1. Apply the rapid separator in several localities on the typodont or other technic block.

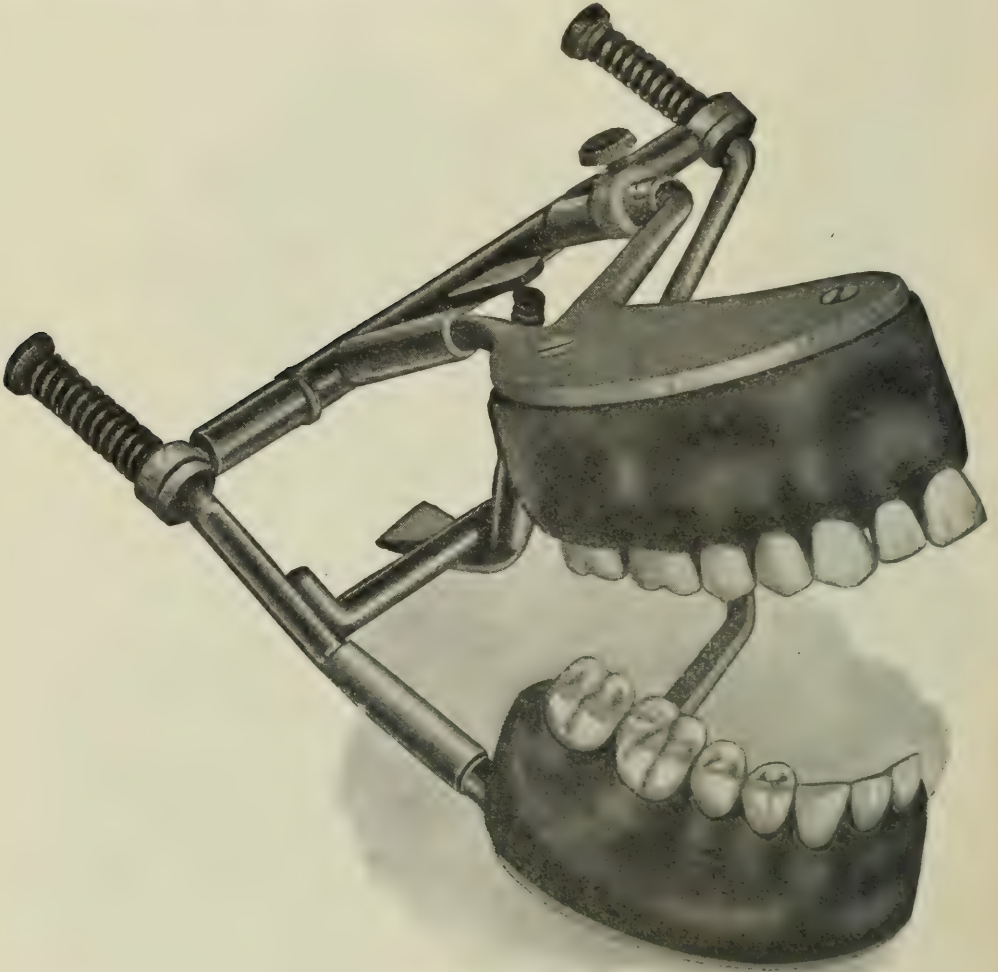


FIG. 299.—The odontotype. Nos. 6 and 7.

*2. Trim several wooden wedges and produce separation in different localities on the technic block.

*3. Apply cotton rolls and napkins with the cotton roll clamp to the technic block.

*4. Adjust the rubber cloth in several localities on the technic form, with the use of ligatures and clamps.

*5. Adjust the matrix to several teeth on the technic form.

C. Cavity Preparation.

*1. **Drawings.**—Outline drawings of the outline form of typical cavities in the occlusal surfaces of upper bicuspid, lower bicuspid, upper molars, lower molars, and the proximal surfaces of the anterior teeth.

*2. **Preparing Mortise Forms.**—Carve to form six cubes of plaster of Paris, 2 inches square, and on these prepare:

- (a) The simple mortise form, one surface.
- (b) The simple mortise form, two surfaces.
- (c) The simple dovetail mortise form, one surface.
- (d) The simple dovetail mortise form, two surfaces.
- (e) The compound mortise form (step form).
- (f) The compound dovetail mortise form.

Study the names of the cavity walls and line and point angles in these imaginary cavities.

- (g) Deepen the convenience angles and bevel the margins.

*3. **Preparing Cavities in the Bone Handle.**—Prepare six cavities in the bone handle, to be later filled with non-cohesive tin.

4. **Preparing Cavities on Enlarged Plaster Teeth.**—Prepare six cavities on the enlarged plaster teeth, carved in the Dental Anatomy Technic Course.

5. **Preparing Cavities in Ivory Teeth.**—Prepare six cavities in the ivory teeth carved in the same course.

6. **Preparing Cavities in Extracted Teeth.**—Prepare six cavities in extracted teeth. In case sufficient work in sawing and filing sections has not been done to impress upon the student's mind the relative thickness of enamel and dentin and the relation of the pulp chamber to the tooth surface, the work in cavity preparation on extracted teeth may be

preceded by exercises in splitting natural teeth and a study of these points.

*7. **Preparing Cavities on the Technic Form.**—Prepare on the Odontotype or the Typodont cavities illustrating all the various classes, to be filled later, some with amalgam, others with gold.

D. Pulp Treatments.

*1. Mount in plaster of Paris an upper central incisor, a cuspid, an upper first bicuspid (two roots), an upper second bicuspid (one root), an upper and a lower molar.

*2. Establish the outline form, remove the decay and make the cavities slightly retentive.

*3. Perform the operations of pulp capping, pressure, anesthesia and devitalization on these teeth.

*4. Open the pulp chambers and canals and seal in treatments of various kinds, practising the two methods of wrapping broaches.

*5. Dry and fill the canals.

*6. Complete the cavity preparation, and place cement intermediates, building some to step form.

E. Filling.

*1. Fill three of the above cavities in the treated teeth with base plate gutta percha and three with cement.

*2. Perform the experiment described on page 156 in mixing and staining cement.

*3. Make from tin foil, specimens of the roll, rope, ribbon, cylinder and mat.

*4. Fill the cavities in the bone handle with tin foil.

5. Fill the cavities prepared in the ivory teeth.

6. Fill the cavities prepared in the extracted teeth.

*7. Fill the cavities prepared on the technic form with amalgam and gold.

F. Inlays.

*₁. Prepare eight cavities of various types in extracted teeth for metal inlay work.

*₂. Make wax models, invest, cast inlays in acolite or an alloy of silver and copper, set and polish.

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